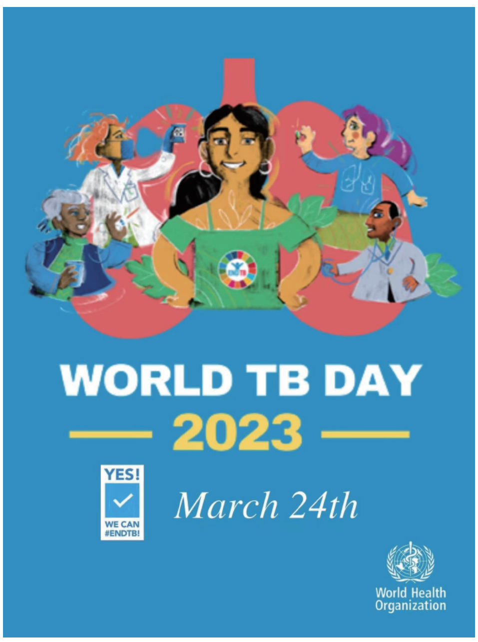
ISSN 2096-7071
CN 10-1629/R1

CHINA CDC WEEKLY

Vol. 5 No. 12 Mar. 24, 2023

CCDC weekly

中国疾病预防控制中心周报



Preplanned Studies

Vital Surveillances

ISSN 2096-7071

Cover Image: adapted from the World Health Organization, https://www.who.int/campaigns/world-tb-day/2023.

Preplanned Studies

Patient, Diagnosis, and Treatment Delays Among Tuberculosis Patients Before and During COVID-19 Epidemic — China, 2018–2022

Tao Li[1,2]; Xin Du[1]; Jiaojie Kang[1]; Dan Luo[3]; Xiaoqiu Liu[1]; Yanlin Zhao[1,#]

Summary

What is already known about this topic?

The coronavirus disease (COVID-19) pandemic could have a damaging impact on access to tuberculosis (TB) diagnosis and treatment.

What is added by this report?

The overall delay experienced by TB patients during the COVID-19 pandemic has shown a modest decrease in comparison to the period before the pandemic. Notably, higher patient delays were observed among agricultural workers and those identified through passive case-finding methods. Furthermore, the patient delay in eastern regions was shorter compared to western and central regions.

What are the implications for public health practice?

The observed increase in patient delay in 2022 should be of concern for ongoing TB control efforts. Health education and active screening initiatives must be enhanced and broadened among high-risk populations and regions characterized by extended patient delays.

Patients with tuberculosis (TB) may experience delays in seeking care for their illness, as well as in obtaining accurate diagnoses and timely treatments. The coronavirus disease (COVID-19) pandemic has the potential to exacerbate these issues, negatively impacting access to TB diagnosis and treatment. Between 2018 and 2022, the number of reported incident TB cases has declined, while trends regarding delays among TB patients remain unclear. This study analyzed records of TB patients reported between 2018 and 2022 across 32 provincial-level administrative divisions (PLADs) in China to determine the long-term trends in delays experienced by TB patients before and during COVID-19 epidemic in China. There were 3,270,346 TB patients involved in the final analysis. The median interquartile range (IQR) of total delay was 29 (12–59) days. Patient delay, diagnosis delay, and treatment delay were 20 (6–46) days, 1 (0–8) days and 0 (0–0) days, respectively. TB patients who were agriculture workers, minorities, detected through passive case finding methods, complicated with comorbidities, and human immunodeficiency virus (HIV) positive had relatively higher patient delays than other subgroups. Patient delay was shorter in eastern regions than in western and central regions. Health education and active screening need to be promoted and expanded among high-risk groups and regions with prolonged patient delay.

TB is a major public health problem. In China, there were an estimated about 780,000 incident TB patients and 30,000 died from the disease in 2021 (*1*). Prompt diagnosis and treatment are crucial for effective TB management and control; however, delays in seeking care are common among TB patients. Delays can occur at any stage from symptom onset to treatment initiation and are typically classified into patient delay (from symptom onset to first medical consultation), diagnostic delay (from first medical consultation to confirmed diagnosis), treatment delay (from confirmed diagnosis to treatment initiation), and total delay (from symptom onset to treatment initiation). Prolonged delays in TB diagnosis and treatment can lead to adverse outcomes, spread of the TB bacteria within communities, and the emergence of multidrug-resistant TB (*2*–*3*).

Globally, the COVID-19 pandemic had a damaging impact on access to TB diagnosis and treatment and the burden of TB disease (*1*). Many factors like nonpharmaceutical interventions (NPIs) and declines in income may affect patients' health care seeking behavior when people become unwell, causing delays in TB diagnosis and treatment. A previous study conducted in 2020 showed that in early period of pandemic, delays for TB patients had not been deeply affected in China. Nevertheless, notification and follow-up examinations were affected significantly (*4*), and these still continue to impact China's TB control. The notification number of incident TB patients has declined by 26.4% between 2018 and 2021 (*1*,*5*).

Whether this effect will have an impact on delays is worrying. This study aimed to analyze long-term trends of delays in TB patients before and during COVID-19 epidemic in China, and describe the socio-demographic, clinical, and tempo-geographic variances of delays among them.

Records of TB patients in 32 PLADs in China, including the Xinjiang Production and Construction Corps, were examined between January 1, 2018, and December 31, 2022. These records were extracted as a Comma-Separated Values (CSV) file from the Chinese Disease Control and Prevention Information System. The analysis included cases with accurate dates of symptom onset, initial medical consultation, and treatment initiation. Data variables were processed in an Microsoft Excel (version 2016; Microsoft Corporation, WA, USA) spreadsheet. Median and IQR were used to summarize delays. Delays were derived from different dates recorded. Illogical delay results (e.g., negative numbers) were excluded from the final analysis. Case finding pathways were derived into two categories: 1) active for those detected through active screening and physical examination; and 2) passive for those detected through direct visiting to designated health facilities, referral, tracing, and recommendation by general health facilities. Descriptive and statistical analysis was done with SAS (version 9.4, SAS Institute, NC, USA). Figures were created using R software (version 4.0.3; R Core Team,Vienna, Austria). The medians of patient delays in different regions were assessed with Kruskall-Wallis independent-samples median test, and pairwise comparisons were further assessed with Dwass, Steel, Critchlow-Fligner (DSCF) tests. A two-sided P-value of 0.05 or less was regarded as significant.

RESULTS

A total of 3,270,346 TB patients were included in the final analysis, representing 99.6% of reported TB cases between January 1, 2018, and December 31, 2022. Sociodemographic, clinical, and management characteristics of the patients are presented in Table 1.

The median and IQR of total delay and its components among TB patients notified between January 1, 2018, and December 31, 2022 was 29 (12–59) days, with patient delay constituting the largest component at 20 (6–46) days. Median (IQR) diagnosis and treatment delays were 1 (0–8) days and 0 (0–0) days, respectively. Male and female TB patients exhibited similar delays. Patients aged 65 and older experienced longer delays than younger age groups. Among various occupations, agricultural workers such as farmers, herdsmen, and fishermen experienced the longest total (30, 13–62) and patient delays (22, 7–50), while students had the shortest (20, 9–41 and 14, 4–32, respectively). Ethnic minorities experienced higher total (31, 13–64) and patient delays (25, 8–53) compared to the Han population (28, 12–58 and 19, 6–45). Migrants from other PLADs had the shortest patient delay (14, 3–37) but the longest diagnosis delay (3, 0–12) compared to local residents and migrants within PLAD. Longer total delays were observed among TB patients detected through passive case-finding (29, 12–60), those who were retreated (31, 13–73), bacteriologically positive (30, 12–63), with radiological TB lesions (29, 13–60), rifampin-resistant (31, 11–70), with comorbidities (32, 14–67), and HIV-positive (33, 15–66) patients, with similar patient delays. Patients with only pulmonary lesions experienced shorter delays compared to those with both pulmonary and extrapulmonary lesions, though patients with only extrapulmonary lesions had the shortest delays.

Trends in diagnosis, treatment, and patient delays have not changed within a 5-year period. Patient delay showed a moderate decrease from 22 (7–48) days in 2018 to 18 (6–43) days in 2021, before increasing slightly to 20 (6–47) days in 2022. These trends were observed in most subgroups, with migrants and individuals identified through active TB screening experiencing a decline over the 5-year period from 2018 to 2022. Conversely, patient delay among those without bacteriological or radiological results exhibited minimal decline and even increased in some years (Table 2).

The distribution of patient delay varied across 32 PLADs, ranging from 5 (0–28) days in Beijing to 31 (10–72) days in Chongqing. Overall, patient delay was shorter in eastern regions (27, 11–55) compared to western (30, 13–64) and central regions (29, 13–56), with significant differences (DSCF values =112.0, 59.2; P<0.001). Central regions also had fewer patient delays than western regions (DSCF value =56.5; P<0.001). However, among eastern regions, Hainan had the longest patient delay (30, 8–60), while within western regions, Xinjiang Corps exhibited the shortest patient delay (10, 3–31) (Figure 1).

DISCUSSION

The overall delay experienced by TB patients during the COVID-19 pandemic has slightly decreased

TABLE 1. Baseline characteristics and timeliness of TB patients notified in 32 PLADs in China, 2018–2022.

Group	Number and percentage (%)	Patient delay Median (IQR)	Diagnosis delay Median (IQR)	Treatment delay Median (IQR)	Total delay Median (IQR)
Total	3,270,346 (100)	20 (6–46)	1 (0–8)	0 (0–0)	29 (12–59)
Gender					
Male	2,239,756 (68.5)	20 (6–46)	1 (0–8)	0 (0–0)	29 (12–59)
Female	1,030,590 (31.5)	20 (6–47)	1 (0–8)	0 (0–0)	29 (12–60)
Age group (years)					
0–14	33,680 (1.0)	15 (5–35)	0 (0.7)	0 (0–0)	22 (10–44)
15–64	2,369,406 (72.5)	20 (6–45)	1 (0–8)	0 (0–0)	28 (12–58)
65 and above	867,260 (26.5)	21 (7–49)	1 (0–8)	0 (0–0)	30 (14–62)
Occupation					
Agriculture workers	2,027,622 (62.0)	22 (7–50)	1 (0.7)	0 (0–0)	30 (13–62)
Houseworkers or unemployees	463,394 (14.2)	19 (5–45)	2 (0–11)	0 (0–0)	28 (12–59)
Industrial workers	140,458 (4.3)	16 (4–39)	2 (0–10)	0 (0–0)	24 (10–51)
Students	200,555 (6.1)	14 (4–32)	1 (0–8)	0 (0–0)	20 (9–41)
Retirees	167,760 (5.1)	18 (6–43)	2 (0–13)	0 (0–0)	28 (12–58)
Others	270,557 (8.3)	15 (4–38)	2 (0–12)	0 (0–0)	24 (10–51)
Ethnics					
Han	2,724,054 (83.3)	19 (6–45)	1 (0–9)	0 (0–0)	28 (12–58)
Minorities	546,292 (16.7)	25 (8–53)	1 (0–6)	0 (0–1)	31 (13–64)
Residence					
Local	2,571,272 (78.6)	21 (7–47)	1 (0–7)	0 (0–0)	29 (13–60)
Migrant–within province	519,054 (15.9)	19 (5–45)	2 (0–12)	0 (0–0)	28 (12–59)
Migrant–out of province	180,020 (5.5)	14 (3–37)	3 (0–12)	0 (0–0)	23 (10–51)
Case finding					
Active	125,664 (3.8)	15 (4–34)	2 (0–10)	0 (0–1)	23 (9–52)
Passive	3,144,682 (96.2)	20 (7.47)	1 (0.8)	0 (0–0)	29 (12–60)
Classification					
Pulmonary TB solo	2,829,581 (86.5)	20 (6–46)	1 (0–8)	0 (0–0)	29 (12–59)
Pulmonary TB complicated with extrapulmonary TB	264,018 (8.1)	22 (8–53)	2 (0–11)	0 (0–0)	31 (14–63)
Extrapulmonary TB solo	176,747 (5.4)	19 (7–39)	1 (0–9)	0 (0–0)	27 (14–50)
Treatment history					
New	3,012,678 (92.1)	20 (6–45)	1 (0–8)	0 (0–0)	28 (12–58)
Retreated	257,668 (7.9)	23 (7–60)	1 (0–8)	0 (0–0)	31 (13–73)
Bacteriological results					
Positive	1,606,960 (49.1)	21 (7–53)	1 (0–8)	0 (0–0)	30 (12–63)
Negative	1,605,704 (49.1)	19 (6–42)	1 (0–8)	0 (0–0)	28 (12–54)
Unknown	57,682 (1.8)	16 (4–40)	0 (0–5)	0 (0–0)	24 (9–52)
Radiological examination					
With TB lesion	2,830,766 (86.6)	20 (7–46)	1 (0–8)	0 (0–0)	29 (13–60)
Without TB lesion	15,973 (0.5)	19 (5–52)	0 (0–7)	0 (0–0)	28 (10–64)
Unknown	423,607 (12.9)	18 (5–44)	1 (0–8)	0 (0–0)	25 (10–55)
Drug resistance					
Rifampin resistant	49,593 (1.5)	22 (6–61)	1 (0–8)	0 (0–0)	31 (11–70)

TABLE 1. (Continued)

Group	Number and percentage (%)	Patient delay Median (IQR)	Diagnosis delay Median (IQR)	Treatment delay Median (IQR)	Total delay Median (IQR)
Rifampin sensitive	1,174,187 (35.9)	21 (6–52)	1 (0–8)	0 (0–0)	29 (12–62)
Unknown	2,046,566 (62.6)	19 (6–43)	1 (0–8)	0 (0–0)	28 (13–56)
Comorbidities					
Yes	383,161 (11.7)	23 (7–59)	2 (0–10)	0 (0–0)	32 (14–67)
No	1,734,878 (53.1)	20 (6–46)	1 (0–8)	0 (0–0)	28 (12–59)
Unknown	1,152,307 (35.2)	19 (6–43)	1 (0–8)	0 (0–0)	28 (12–56)
HIV					
Positive	25,512 (0.8)	27 (9–57)	1 (0–10)	0 (0–0)	33 (15–66)
Negative	1,905,867 (58.3)	20 (6–46)	1 (0–9)	0 (0–0)	28 (12–60)
Unknown	1,338,967 (40.9)	20 (6–45)	1 (0–7)	0 (0–0)	29 (12–59)

Note: Patient delay means from symptom onset to first seeking medical care; Diagnosis delay means from first seeking medical care to diagnosis confirmation; Treatment delay means from diagnosis confirmation to treatment initiation; Total delay means from symptom onset to treatment initiation.

Abbreviation: TB=tuberculosis; PLADs=provincial-level administrative divisions; HIV=human immunodeficiency virus; IQR=interquartile range.

TABLE 2. Patient delays among TB patients across various groups, stratified by year, in 32 PLADs in China, 2018–2022.

Group	2018 Median (IQR)	2019 Median (IQR)	2020 Median (IQR)	2021 Median (IQR)	2022 Median (IQR)
Total	22 (7, 48)	21 (7, 46)	19 (6, 46)	18 (6, 43)	20 (6, 47)
Gender					
Male	21 (7, 28)	21 (7, 46)	19 (6, 46)	18 (6, 43)	20 (6, 47)
Female	22 (7, 49)	21 (7, 47)	19 (6, 47)	18 (6, 43)	19 (6, 47)
Age groups (years)					
0–14	16 (5, 37)	16 (5, 36)	15 (5, 34)	14 (5, 33)	15 (5, 37)
15–64	21 (7, 47)	20 (6, 45)	19 (6.46)	18 (6, 43)	19 (5, 47)
65 and above	24 (8, 52)	23 (7, 49)	21 (7, 49)	20 (7, 45)	21 (7, 48)
Occupation					
Agriculture workers	25 (8, 54)	23 (8, 51)	21 (7, 51)	20 (7, 46)	21 (7, 50)
Houseworkers or unemployees	20 (6, 44)	20 (6, 45)	18 (5, 46)	18 (5, 43)	19 (5, 46)
Industrial workers	16 (5, 40)	17 (5, 40)	15 (4, 39)	15 (4, 37)	15 (4, 40)
Students	14 (4, 33)	14 (4, 32)	14 (4, 32)	13 (4, 31)	14 (4, 34)
Retirees	19 (6, 45)	18 (6, 42)	18 (6, 43)	17 (5, 41)	19 (6, 45)
Others	16 (5, 38)	15 (4, 37)	14 (4, 38)	14 (3, 36)	16 (4, 41)
Ethnics					
Han	20 (6, 46)	20 (6, 45)	19 (6, 45)	18 (6, 43)	19 (6, 47)
Minorities	30 (10, 59)	28 (9, 53)	22 (7, 52)	20 (7, 45)	20 (6, 48)
Residence					
Local	23 (7, 49)	22 (7, 47)	20 (7, 27)	19 (6, 44)	20 (6, 48)
Migrant-within province	19 (6, 46)	19 (5, 44)	19 (6, 46)	17 (5, 41)	15 (3, 38)
Migrant-out of province	15 (3, 38)	15 (3, 39)	14 (3, 37)	13 (3, 34)	13 (2, 34)
Case finding					
Active	21 (6, 38)	21 (6, 38)	12 (4, 31)	10 (2, 27)	8 (1, 24)
Passive	22 (7, 49)	21 (7, 47)	20 (6, 47)	19 (6, 44)	20 (6, 48)
Classification					
Pulmonary TB solo	22 (7, 48)	21 (7, 46)	19 (6, 46)	18 (6, 43)	19 (5, 47)

TABLE 2. (Continued)

Group	2018 Median (IQR)	2019 Median (IQR)	2020 Median (IQR)	2021 Median (IQR)	2022 Median (IQR)
Pulmonary TB complicated with extrapulmonary TB	23 (8, 55)	23 (8, 53)	22 (8, 55)	22 (8, 50)	22 (8, 52)
Extrapulmonary TB solo	20 (8, 40)	19 (7, 39)	18 (7, 38)	18 (7, 38)	18 (7, 40)
Treatment history					
New	21 (7, 47)	20 (7, 45)	19 (6, 45)	18 (6, 42)	19 (6, 46)
Retreated	27 (8, 61)	25 (7, 61)	23 (7, 61)	21 (7, 53)	20 (6, 58)
Bacteriological results					
Positive	24 (7, 59)	22 (7, 54)	21 (7, 54)	20 (6, 48)	21 (6, 52)
Negative	21 (7, 44)	20 (7, 42)	18 (6, 41)	17 (6, 39)	18 (5, 41)
Unknown	16 (4, 41)	17 (5, 41)	17 (4, 38)	15 (2, 38)	16 (2, 43)
Radiological examination					
With TB lesion	22 (7, 48)	21 (7, 46)	19 (6, 47)	19 (6, 43)	21 (7, 49)
Without TB lesion	23 (7, 59)	18.5 (4, 49)	16 (5, 49)	16 (5, 50)	15 (4, 47)
Unknown	14 (1, 36)	13 (1, 35)	15 (2, 39)	14 (3, 35)	19 (5, 46)
Drug resistance					
Rifampin resistant	24 (7, 61)	24 (7, 60)	22 (6, 61)	20 (6, 59)	22 (5, 62)
Rifampin sensitive	24 (7, 59)	22 (7, 54)	21 (6, 55)	20 (6, 47)	20 (6, 51)
Unknown	21 (7, 46)	20 (7, 43)	18 (6, 42)	17 (6, 40)	18 (5, 43)
Comorbidities					
Yes	27 (9, 61)	25 (8, 61)	22 (7, 60)	21 (7, 52)	23 (7, 57)
No	21 (7, 50)	20 (7, 47)	19 (6, 46)	18 (6, 42)	19 (6, 46)
Unknown	21 (7, 43)	20 (6, 41)	18 (6, 42)	18 (6, 41)	19 (5, 46)
HIV					
Positive	30 (10, 61)	28 (10, 59)	26 (9, 60)	25 (9, 52)	24 (8, 51)
Negative	22 (7, 49)	21 (7, 47)	19 (6, 47)	18 (6, 43)	19 (6, 46)
Unknown	21 (7, 47)	20 (7, 44)	20 (6, 46)	19 (6, 43)	20 (5, 47)

Note: Patient delay means from symptom onset to first seeking medical care; Diagnosis delay means from first seeking medical care to diagnosis confirmation; Treatment delay means from diagnosis confirmation to treatment initiation; Total delay means from symptom onset to treatment initiation.

Abbrevieation: TB=tuberculosis; PLADs=provincial-level administrative divisions; HIV=human immunodeficiency virus; IQR=interquartile range.

compared to pre-pandemic levels. The patient delay was the primary factor contributing to the total delay. TB patients who were agricultural workers, from minority populations, identified through active screening, and those with comorbidities or who were HIV positive experienced relatively longer patient delays compared to other subgroups. Additionally, patient delay was shorter in the eastern regions of the study area compared to the western and central regions.

A previous study conducted in 2021 (*6*) demonstrated that COVID-19 can influence the behavior of TB patients seeking medical care. Over twenty percent of patients might postpone seeking medical care due to transportation restrictions, disruptions in TB services, and personal reasons. However, the current study did not find any significant increase in delays after 2019. Given that TB is a respiratory disease with symptoms similar to those of COVID-19, the heightened attention paid by patients, communities, and healthcare facilities could be the primary reason for the absence of additional delays. Another contributing factor is China's strict NPIs strategy during the pandemic period, which caused COVID-19 not to reach true nationwide transmission until the end of 2022. Its impact can vary across time and region according to COVID-19 epidemic and different public health responses. Ningxia has reported a longer patient delay during early 2020 compared to pre-pandemic period (*7*). On the contrary, pulmonary

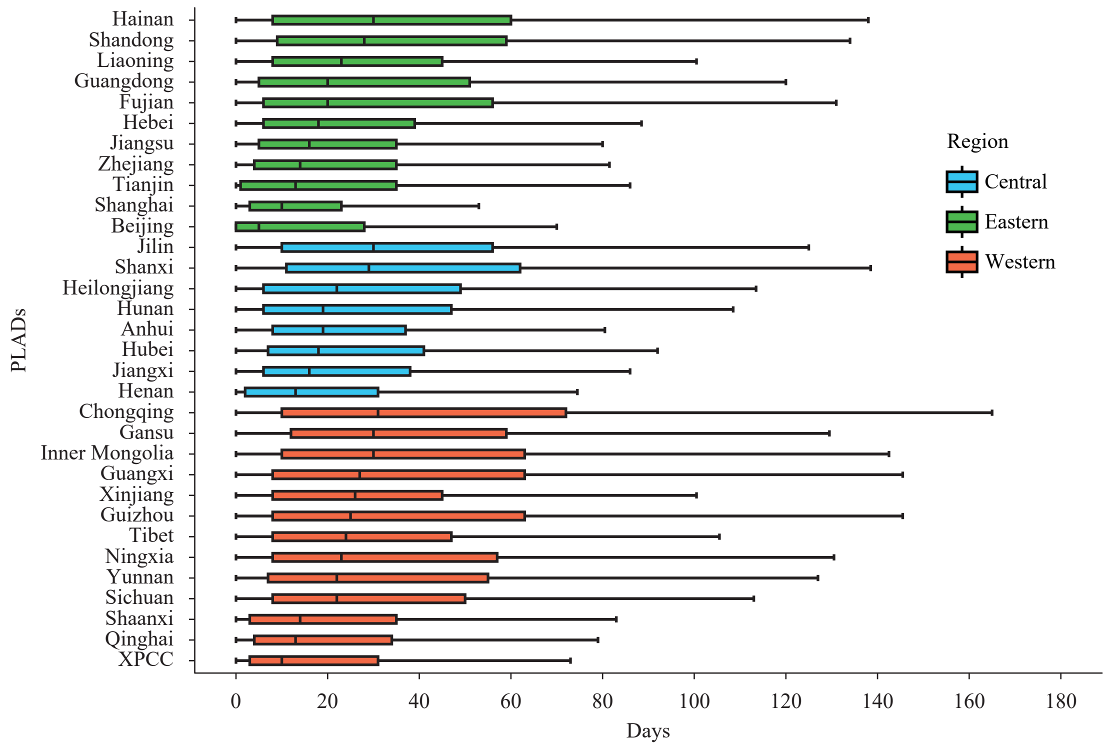


FIGURE 1. Patient delays among tuberculosis patients across 32 PLADs in China, 2018–2022.
Abbreviation: PLADs=provincial-level administrative divisions; XPCC=Xinjiang Production and Construction Corps.

TB patients in Tianjin experienced a shorter patient delay during almost the same period (*8*). Nevertheless, the continuous low level of diagnosis and treatment delays can also be evidence for generally non-serious interruption of TB service during COVID-19 epidemic.

Compared to other occupations, agricultural workers often experience poorer health equity. Their remote living conditions and relatively lower income make it more challenging for them to access healthcare facilities when TB symptoms arise. However, the shorter patient delay observed among students may suggest that TB education and control efforts in schools have been effective in recent years. Migrant TB patients have also had less patient delay than local residents in this analysis. Generally, migrant population was considered as one of three major challenges in TB control. Stigma, poor accessibility to health service and many other factors may influence their health-seeking behavior (*9*). The National TB Program (NTP) started focusing on this vulnerable population since the early 21st century. Many active screening and health promotion activities have been implemented and a specific guideline for cross-regional management of TB patients (*10*) was launched in 2009. The patient delays were much shorter in eastern regions especially in the biggest cities. It is not surprising that Beijing, Shanghai, and Tianjin had shorter patient delays than most other regions since they have the richest medical resources and people living in these regions may have higher health knowledge. Besides changing individuals' personal perspectives through health education, active case-finding is the most useful method to reduce patient delay (*11*). Results from this study further confirmed its effectiveness. However, the proportion of patients detected through active screening still accounted for a minority in all patients. NTP should consider promoting the strategy in larger coverage.

The present study has certain limitations. First, we were unable to quantify the correlation between the COVID-19 pandemic and changes in delays. Furthermore, it is important to note that the number of TB notifications declined by more than a quarter from 2018 to 2021 (*1*), which could suggest that patients seeking treatment at health facilities exhibited more severe symptoms. In addition, as our study is a retrospective analysis utilizing surveillance data, we could not determine the existence of undetected patients or the impact of these undetected patients on average delays. Lastly, our dataset did not include various social and environmental factors, such as health service accessibility and income, which may have affected the results. Future research should be conducted to identify potential risk factors, especially in different settings, to provide a more comprehensive understanding of the situation.

There is no evidence indicating that delays for TB patients worsened during the COVID-19 pandemic in China. However, the observed increase in patient delays in 2022 warrants attention for ongoing TB control efforts. Health education and active screening should be enhanced and expanded among high-risk populations and in regions experiencing prolonged patient delays.

Funding: This work was supported by the Epidemic of Tuberculosis Recurrence and Types of Recent Recurrence in Western China (JY22-3-11), Chinese Center for Disease Control and Prevention.

doi: 10.46234/ccdcw2023.047

Corresponding author: Yanlin Zhao, zhaoyl@chinacdc.cn.

[1] National Center for Tuberculosis Control and Prevention, China CDC, Beijing, China; [2] School of Public Health, Peking University, Beijing, China; [3] Department of Public Health, Hangzhou Medical College, Hangzhou City, Zhejiang Province, China.

Submitted: March 07, 2023; Accepted: March 22, 2023

REFERENCES

1. World Health Organization. Global tuberculosis report 2022. Geneva: WHO; 2022. https://www.who.int/publications/i/item/9789240061729.
2. Gebreegziabher SB, Bjune GA, Yimer SA. Total delay is associated with unfavorable treatment outcome among pulmonary tuberculosis patients in West Gojjam Zone, Northwest Ethiopia: a prospective cohort study. PLoS One 2016;11(7):e0159579. http://dx.doi.org/10.1371/journal.pone.0159579.
3. Nkosi D, Janssen S, Padanilam X, Louw R, Menezes CN, Grobusch MP. Factors influencing specialist care referral of multidrug- and extensively drug-resistant tuberculosis patients in Gauteng/South Africa: a descriptive questionnaire-based study. BMC Health Serv Res 2013;13:268. http://dx.doi.org/10.1186/1472-6963-13-268.
4. Huang F, Xia YY, Chen H, Wang N, Du X, Chen W, et al. The impact of the COVID-19 epidemic on tuberculosis control in China. Lancet Reg Health West Pac 2020;3:100032. http://dx.doi.org/10.1016/j.lanwpc.2020.100032.
5. World Health Organization. Global tuberculosis report 2019. Geneva: WHO. 2019. https://www.who.int/publications/i/item/9789241565714.
6. Xia YY, Huang F, Chen H, Wang N, Du X, Chen W, et al. The impact of COVID-19 on tuberculosis patients' behavior of seeking medical care — China, 2020. China CDC Wkly 2021;3(26):553 – 6. http://dx.doi.org/10.46234/ccdcw2021.143.
7. Wang XL, He WC, Lei J, Liu GT, Huang F, Zhao YL. Impact of COVID-19 pandemic on pre-treatment delays, detection, and clinical characteristics of tuberculosis patients in Ningxia Hui autonomous region, China. Front Public Health 2021;9:644536. http://dx.doi.org/10.3389/FPUBH.2021.644536.
8. Zhang GQ, Yu YM, Zhang WQ, Shang J, Chen SY, Pang XW, et al. Influence of COVID-19 for delaying the diagnosis and treatment of pulmonary tuberculosis–Tianjin, China. Front Public Health 2022;10:937844. http://dx.doi.org/10.3389/fpubh.2022.937844.
9. Abarca Tomás B, Pell C, Bueno Cavanillas A, Guillén Solvas J, Pool R, Roura M. Tuberculosis in migrant populations. A systematic review of the qualitative literature. PLoS One 2013;8(12):e82440. http://dx.doi.org/10.1371/journal.pone.0082440.
10. Chinese Center for Diseases Control and Prevention. National cross regional tuberculosis patient management procedure (Trial) [Internet]. 2009. http://www.jygcdc.com/html/col15/content15_1172.html. (In Chinese).
11. World Health Organization. Systematic screening for active tuberculosis: an operational guide. Geneva: WHO; 2013:1-146. https://www.who.int/publications/i/item/9789241549172.

Preplanned Studies

Financial Burden of Tuberculosis Patients — China, 2020

Caihong Xu[1]; Yinyin Xia[1]; Dongmei Hu[1]; Xiaomeng Zhang[2]; Yanlin Zhao[1,#]

Summary

What is already known about this topic?

Tuberculosis (TB) is often referred to as "a disease of poverty," yet the information regarding the financial burden of TB care is limited and regionally representative.

What is added by this report?

This manuscript reported the national representative total and breakdown costs associated with TB care in China. The total cost per patient was 1,185 USD, of which 88% was direct cost and 37% was incurred prior to TB treatment.

What are the implications for public health practice?

TB patients experience a significant financial burden, and disparities exist among different regions and populations. Current TB care policies and packages are not sufficient to address this issue.

Tuberculosis (TB) is often regarded as "a disease of poverty". In China, a basic package of free services (including chest radiography, sputum smear test, and first-line drugs) is provided to TB cases, while other costs are covered by public-funded medical insurance schemes. However, there is limited information available on whether the current policy is sufficient to avoid the heavy economic burden of TB care. To address this, a cross-sectional study involving primary data collection was conducted in 41 counties in China in 2020 to obtain a nationally representative assessment of the financial burden of TB care. The results showed that the direct costs, indirect costs, and total costs due to TB care were 1041.3 USD, 12.7 USD, and 1185.5 USD per patient, respectively. Direct costs accounted for 88% and 37% of costs incurred before patients arrived at TB-designated hospitals. Governments need to increase TB investment and improve medical insurance levels. Doctors from TB-designated hospitals should conduct TB diagnosis and treatment in accordance with norms and guidelines to reduce total costs. Health staff of general hospitals should also improve awareness of TB and refer presumptive TB patients to TB-designated medical facilities in a timely manner, thus reducing delays in TB care and costs before they reach TB-designated hospitals.

The End TB Strategy aims to ensure that by 2020, no households affected by TB will experience catastrophic costs due to the disease (*1*). This is in line with the World Health Organization's (WHO) policy to move health systems closer to universal health coverage (UHC) (*2*). Despite the availability of free TB care services and public-funded medical insurance systems, TB patients in some regions still face a heavy financial burden. However, there is no nationally representative data on this issue in China.

This TB patient cost survey was part of a comprehensive evaluation of the National Tuberculosis Prevention and Control Plan (2016–2020). The survey was conducted between October and December 2020, in accordance with the WHO recommended methodology (*3*). The study population was defined as drug-susceptible pulmonary TB patients who had received at least two weeks of therapy under the National Tuberculosis Programme (NTP). Assuming a catastrophic cost due to TB of 50%, a relative precision of 0.2, and an alpha error of 0.05, the average cluster size (defined at the county level) for each designated TB medical institution was calculated as 0.83, and the effective response rate was set at 80%. Thus, the sample size was determined to be a total of 2,250 patients in 41 institutions. The main stratification factors considered in multistage stratified sampling were urban and rural areas. According to the proportion of registered tuberculosis patients in urban and rural areas in 2019 (51.9% and 48.1%), the number of designated medical institutions in urban and rural areas was determined to be 21 and 20, respectively. Face-to-face interviews were conducted by trained investigators using a structured questionnaire. Patients presented health insurance cards and treatment fee documents, if available. Data were double-entered and validated using EpiData (version 3.1 EpiData Association, Odense, Denmark). The analysis was conducted using STATA (version 12.1, copyright 1985–2011 StataCorp LP USA). A currency exchange rate of 645 CNY to 100 USD (December 2020) was used. The operational definitions were as follows: 1) Direct medical costs: Out-of-pocket (OOP) medical expenditures associated with TB diagnosis, treatment, and treatment-seeking; 2) Direct non-medical costs: OOP costs for transportation, accommodation, and food of the patients and family members; 3) Direct costs: Direct medical and direct non-medical costs combined; 4) Indirect costs: Productivity and economic costs of a patient and their household incurred as a result of TB care visits and hospitalization during the TB episode; 5) Total costs: Direct and indirect costs combined.

A total of 3,286 TB patients were surveyed, of whom 2,201 (67.0%) were male. The median (interquartile range, IQR) monthly income per capita was 148 USD (61.7–246.7). The incomes of 704 (21.4%) households were below the poverty line. The New Rural Cooperative Medical Scheme (NRCMS) covered 2,394 (72.8%) of the patients (Table 1). The total TB care costs were 1185.5 USD (596.0–2230.8). The total TB care costs were relatively high among people over 65 years old (χ^2=50.3, P<0.0001), divorced and widowed (χ^2=52.6, P<0.0001), those in the western region (χ^2=14.4, P=0.0008), those in rural areas (χ^2=9.2, P=0.0025), those with education below primary school (χ^2=16.6, P=0.0023), those without insurance (χ^2=44.9, P<0.0001), and those in low-income household (χ^2=40.6, P<0.0001) (Table 1). The median (IQR) direct, indirect, and total costs due to TB care were 1041.3 USD (534.5–1965.0), 12.7 USD (0.2–194.3), and 1185.5 USD (596.0–2230.8) per patient, respectively (Table 2). The direct costs accounted for 88.0% of the total costs, while the direct medical costs accounted for 69% of total costs. Of the total costs, 37% were incurred before patients arrived at TB-designated hospitals (Figure 1).

DISCUSSION

The national representative TB cost survey showed that the total costs and direct medical costs of TB patients in China are relatively high despite the basic free-TB care package and public-funded medical insurance schemes in China. Besides the first-line drugs and smear sputum tests, the government needs to expand free TB care package to include some adjuvant drugs, bacteriological examinations, and adverse reaction therapy support. Also, the reimbursement level for TB care should be increased. The economic burden differed among different groups, regions, insurance schemes, and incomes. People older than 65 years, divorced and widowed, residing in west regions, residing in rural areas, having education below primary school, having no insurance, and those in low-income households incurred a heavier economic burden. Medical and social assistance policies are needed to improve the equity of TB services and reduce the economic burden of vulnerable groups in key areas and populations, especially for vulnerable populations such as those with income below poverty line, a wider health welfare is needed. The cost before referral to the TB-designated medical institution accounts for a large proportion of the total cost, which suggests a significant delay in TB diagnosis and transfer. On the one hand, further training for the general hospital (that are not authorized to diagnose and treat TB) doctors are needed to improve the identification capacity and referral awareness for TB and presumptive TB cases. Health promotion for the public also needs to be enhanced to reduce delays in seeking medical consults. The median costs that TB patients incurred in China (1185.5 USD) were higher than those in Vietnam (1,054 USD) (*4*), Ghana (429.6 USD) (*5*), and Indonesia (133 USD) (*6*). Nearly 40% of the costs were spent before TB treatment initiation, which was higher than in Ghana (7%) and Indonesia (11%) (*5*–*6*), but was consistent with findings from the systematic reviews by Tanimura T, et al. (*7*) and Ukwaja KN, et al. (*8*). The most significant driver of costs was direct medical costs (69%) which were much higher than in Vietnam (44%) and Ghana (18.2%) (*4*–*5*). In August 2021, the Ministry of Finance of the National Medical Insurance Administration issued “Establishment of a medical security benefits list system”. Tuberculosis was listed as a chronic disease in outpatient department, which can refer to the management and reimbursement of hospitalization, thus improving the reimbursement ratio of tuberculosis to a certain extent and reducing the economic burden of patients. The data was collected through a face-to-face questionnaire survey. Some patients may not

TABLE 1. Demographic of the patients and costs due to TB care incurred by patients enrolled in TB patient cost survey, China, 2020 (N=3,286).

Variable	Demographic profile		Costs (USD)	Kruskal-wallis test	
	N	Prevalence (%)	Median (IQR)	χ^2 value	*P* value
Total	3,286	100.0	1185.5 (596.0–2230.8)		
Age (years)					
<15	51	1.6	1079.9 (444.0–2597.2)	50.3	<0.0001
15–44	1,155	35.2	1016.5 (468.7–1960.5)		
45–64	1,211	36.9	1234.7 (621.6–2299.6)		
≥65	869	26.5	1342.2 (737.8–2366.0)		
Gender					
Male	2,201	67.0	1141.6 (585.8–2166.7)	4	0.0443
Female	1,085	33.0	1273.7 (610.3–2381.0)		
Marital status					
Unmarried	689	21.0	931.8 (428.1–1801.0)	52.6	<0.0001
Married	2,296	69.9	1235.9 (635.6–2293.8)		
Divorced	105	3.2	1378.4 (676.7–3057.5)		
Widowed	195	5.9	1477.1 (804.2–2510.1)		
Region					
East	986	30.0	1107.9 (441.1–2251.1)	14.4	0.0008
Middle	1,270	38.7	1152.1 (689.4–2105.9)		
West	1,030	31.4	1288.1 (602.1–2325.9)		
Residence					
Urban	1,564	47.7	1170.6 (490.0–2209.3)	9.2	0.0025
Rural	1,718	52.4	1192.4 (645.8–2246.0)		
Education					
Illiterate or not completed primary school	517	15.7	1416.0 (697.4–2299.6)	16.6	0.0023
Completed primary school	1012	30.8	1218.0 (615.0–2314.9)		
Completed middle school	962	29.3	1116.3 (574.0–2089.5)		
Completed high school	444	13.5	1081.5 (516.3–2071.7)		
Completed college and above	350	10.7	1168.8 (558.5–2330.6)		
Insurance					
None	85	2.6	1704.4 (713.8–3655.8)	44.9	<0.0001
UEBMI	771	23.5	972.7 (279.9–2325.9)		
NRCMS	2,394	72.8	1223.5 (657.9–2180.5)		
Other insurance	36	1.1	943.4 (444.8–1349.5)		
Economic activity					
Formal sector	671	20.4	1211.3 (634.5–2370.7)	4.3	0.1189
Informal sector	1,660	50.5	1133.9 (566.5–2145.8)		
Economically inactive	954	29.1	1245.9 (618.5–2264.4)		
Migrant status (Yes)*	59	1.8	1106.7 (614.0–1941.4)	0	0.8594
Low income line (Yes)†	704	21.4	972.3 (360.7–1956.0)	40.6	<0.0001
Prime income earner (Yes)	1,269	38.6	1153.7 (604.2–2325.9)	0.6	0.4384

Abbreviation: TB=tuberculosis; USD=US dollar; IQR=interquartile range; UEBMI=urban employee basic medical insurance; NRCMS=new rural cooperative medical scheme.

* Migrant stays for less than six months at the residence at the time of diagnosis.

† Low income line in China is annual per capita household income less than 430 USD.

TABLE 2. Costs due to TB care incurred by patients at different stages enrolled in TB patient cost survey, China, 2020 (*N*=3,286).

Costs (USD)	Before-TB designated hospital		After-TB designated hospital		TB care overall	
	Median	(IQR)	Median	(IQR)	Median	(IQR)
Direct costs*	210.2	(34.0–747.4)	494.0	(206.5–1154.3)	1041.3	(534.5–1965.0)
Direct medical costs†	148.8	(22.2–579.1)	369.4	(149.8–883.0)	786.8	(385.6–1520.6)
Direct non-medical costs§	26.6	(2.2–133.2)	104.8	(33.8–268.4)	206.9	(89.1–443.7)
Transport	5.9	(0–22.2)	25.2	(12.1–59.2)	39.9	(18.2–91.4)
Food	7.4	(0–77.0)	33.8	(7.7–149.3)	113.5	(32.6–249.3)
Accommodation	0	(0–0)	0	(0–1.6)	0.1	(0–7.3)
Nutritional supplement	0	(0–14.8)	5.7	(0–29.5)	17.2	(0.5–48.8)
Indirect costs¶	0	(0–29.6)	2.8	(0.1–64.2)	12.7	(0.2–194.3)
Total costs**	230.1	(38.5–849.5)	551.0	(223.5–1297.6)	1185.5	(596.0–2230.8)

Abbreviation: TB=tuberculosis; USD=US dollar; IQR=interquartile range.
* Direct medical and direct non-medical costs combined.
† Out of pocket (OOP) medical expenditures associated with TB diagnosis, treatment and treatment seeking.
§ OOP costs for transportation, accommodation and food of the patients and family members.
¶ Productivity and economic costs of a patient and his/her household incurred as a result of TB care visits and hospitalization during the TB episode.
** Direct and indirect costs combined.

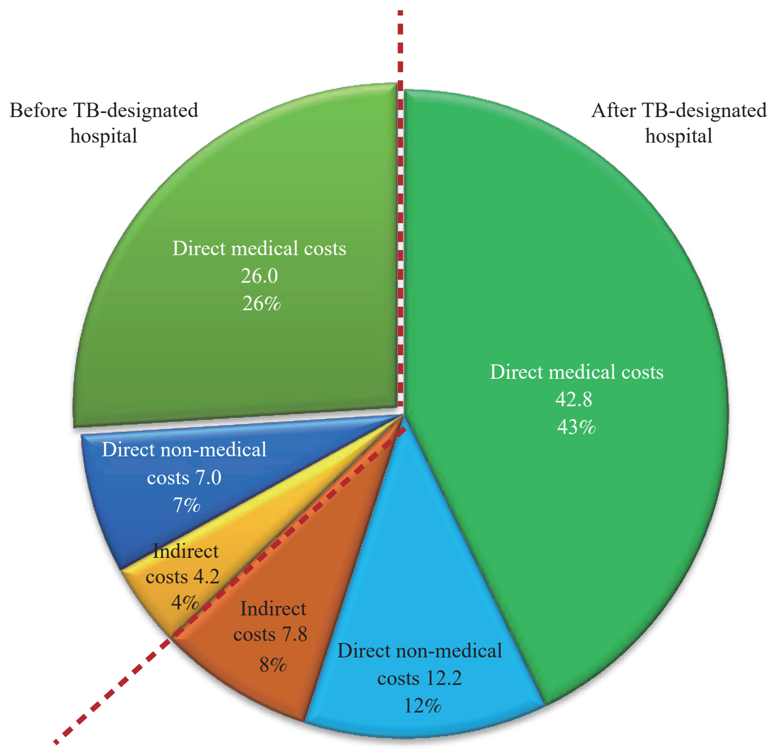


FIGURE 1. Contribution of each component of costs due to TB care as a proportion of total costs among patients enrolled in TB patient cost survey, China, 2020 (*N*=3,286).

accurately remember the exact costs incurred. We attempted to minimize recall limitations by surveying patients still on treatment and imputing costs to the entire episode assuming that all patients would complete treatment. This might overestimate the costs considering some patients may fail treatment or be lost to follow-up. Most patients could not provide the breakdown of direct medical costs. Therefore, detailed information on components of direct medical costs is not presented.

The costs of TB patients in China are relatively high despite the basic free TB care package and public-funded medical scheme. The significant differences among different regions and populations indicate the geographic and economic disparities in health equity. It is urgent to increase government investment and social security measures to reduce the economic burden of TB patients and move health systems closer to UHC.

Acknowledgments: All participants who contributed to the survey from the Centers for Disease Control and Prevention (CDC), hospitals, and health facilities.

doi: 10.46234/ccdcw2023.048

Corresponding author: Yanlin Zhao, zhaoyl@chinacdc.cn.

[1] National Center for Tuberculosis Control and Prevention, Chinese Centre for Disease Control and Prevention, Beijing, China; [2] Tianjin Center for Tuberculosis Control, Tianjin, China.

Submitted: March 02, 2023; Accepted: March 20, 2023

REFERENCES

1. World Health Organization. The end TB strategy. Geneva: World Health Organization; 2015. https://www.who.int/publications/i/item/WHO-HTM-TB-2015.19. [2023-2-23].
2. World Health Organization. Health in 2015: from MDGs, Millennium Development Goals to SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2015; https://apps.who.int/iris/handle/10665/200009?search-result=true&query=Health+in+2015%3A+from+MDGs%2C+Millennium+Development+Goals+to+SDGs%2C+Sustainable+Development+Goals&scope=&rpp=10&sort_by=score&order=desc. [2023-2-23].
3. World Health Organization. Tuberculosis patient cost surveys: a handbook. Geneva: World Health Organization. 2017. https://www.who.int/publications/i/item/9789241513524. [2023-2-23].
4. Nhung NV, Hoa NB, Anh NT, Anh LTN, Siroka A, Lönnroth K, et al. Measuring catastrophic costs due to tuberculosis in Viet Nam. Int J Tuberc Lung Dis 2018;22(9):983 – 90. http://dx.doi.org/10.5588/ijtld.17.0859.
5. Pedrazzoli D, Siroka A, Boccia D, Bonsu F, Nartey K, Houben R, et al. How affordable is TB care? Findings from a nationwide TB patient cost survey in Ghana. Trop Med Int Health 2018;23(8):870 – 8. http://dx.doi.org/10.1111/tmi.13085.
6. Fuady A, Houweling TAJ, Mansyur M, Richardus JH. Catastrophic total costs in tuberculosis-affected households and their determinants since Indonesia's implementation of universal health coverage. Infect Dis Poverty 2018;7(1):3. http://dx.doi.org/10.1186/s40249-017-0382-3.
7. Tanimura T, Jaramillo E, Weil D, Raviglione M, Lönnroth K. Financial burden for tuberculosis patients in low- and middle-income countries: a systematic review. Eur Respir J 2014;43(6):1763 – 75. http://dx.doi.org/10.1183/09031936.00193413.
8. Ukwaja KN, Alobu I, Abimbola S, Hopewell PC. Household catastrophic payments for tuberculosis care in Nigeria: incidence, determinants, and policy implications for universal health coverage. Infect Dis Poverty 2013;2(1):21. http://dx.doi.org/10.1186/2049-9957-2-21.

Preplanned Studies

Factors Associated with PCV13 Vaccine Hesitancy in Parents under an Innovative Immunization Strategy: a Cross-Sectional Study — Weifang City, Shandong Province, China, 2021

Yuanze Du[1]; Yan Wang[1]; Ting Zhang[2]; Libing Ma[2,3]; Shuyun Xie[4]; Yi Wang[5]; Yuan Yang[6]; Juanjuan Li[1]; Yushu Feng[7]; Yujue Wang[8]; Weiran Qi[2]; Weizhong Yang[2]; Jian Zhou[9,#]; Chunping Wang[1,#]; Luzhao Feng[2,#]

Summary

What is already known on this topic?

Pneumococcal diseases (PDs) are serious threats to child health. Although vaccination is one of the most effective ways to prevent these diseases, the pneumococcal vaccination coverage rate is still relatively low in China.

What is added by this report?

This study investigated the factors associated with 13-valent pneumococcal conjugate vaccine (PCV13) vaccine hesitancy in parents under an innovative immunization strategy. This study found that 29.7% of the participants hesitated to vaccinate their children against PCV13 and the main reasons for vaccine hesitancy were individual and group influences.

What are the implications for public health practice?

This study can provide scientific evidence for further improving children's PCV13 vaccination rate and improving the prevention and control strategy for PDs.

Pneumococcal diseases (PDs) have become a serious public health problem worldwide. According to the latest research data released by the World Health Organization (WHO) in 2018, about 294,000 children under the age of 5 died from Streptococcus pneumonia (Spn) infection globally (*1*). WHO asserts that pneumococcal vaccination is the most cost-effective way to prevent pneumococcal diseases. The infrequent occurrence of adverse vaccine side effects, lack of understanding, and distribution of misinformation, however, have led to a decline in the public's trust in vaccines in recent years, an increase in parents' vaccine hesitancy, and even more vaccine hesitancy in non-national immunization programs (*2*). In China, the 13-valent pneumococcal conjugate vaccine (PCV13) was officially launched in 2020. Until now, no study has focused on PCV13 vaccine hesitancy in China. In 2021, the Government of Weifang City, Shandong Province, launched the first program in China to vaccinate registered children from 6 months to 2 years old with a free dose of domestic PCV13. Based on this innovative immunization strategy, we analyzed PCV13 vaccine hesitancy and influential factors for parents when making vaccine decisions for their children. The study found that 29.7% of participants were hesitant to vaccinate their children against PCV13. The most important reason for vaccine hesitancy is lack of knowledge about the vaccine.

Based on data from the children's vaccination information management system in Weifang City, Shandong Province, this study calculated the birth population and the children being vaccinated in each vaccination clinic in 2021. By systematic sampling method, this study selected a total of 57 vaccination clinics from 12 counties as survey sites. All participants were surveyed after their informed consent. The sample size required for this survey was estimated according to the cross-sectional survey formula with an absolute tolerance error of d=3.0%. Considering that participants might reject the survey because their children were too young, the rejection rate was estimated to be 10.0%. Therefore, the final sample size was estimated to be 1,174. The specific calculation formula and the inclusion and exclusion criteria of participants are outlined in a previously published article (*3*).

After literature screening, research group discussions, and expert consultation, we designed the questionnaire. Pre-investigation was conducted prior to a formal investigation and all investigators were trained uniformly to the same standards. The investigators used the Pad that had been imported into the questionnaire to conduct the investigation. The questionnaire included six main aspects: sociodemographic characteristics of participants, participants' perceptions of vaccine knowledge,

knowledge of pneumonia and pneumococcal vaccine, willingness to receive pneumococcal vaccine, willingness to pay for pneumococcal vaccine, visiting behavior of children with pneumonia. It is important to note that if participants had multiple children, the study was aimed at the youngest child in the family.

SPSS (version 22.0; SPSS Inc., Chicago, IL, USA) was used to complete all data sorting, and classification variables were expressed in frequency (percentage). Chi-square test was used for comparison. Binary logistic regression model was used to analyze the related factors of pneumococcal vaccine hesitation. All statistical methods were adopted by the two-tailed test, and $P<0.05$ was considered statistically significant. To analyze the reasons for vaccine hesitancy, the WHO vaccine hesitancy determinants matrix was used for judgment (*4*), which mainly included three categories: contextual, individual and group, and vaccine/vaccination-specific influences.

A total of 1,195 questionnaires were collected in this survey, of which 1,110 were valid, with an effective questionnaire rate of 93.0%. Among the 1,110 participants, more than half were 31 to 40 years old (52.1%), 35.4% were fathers, 61.0% were mothers, and 3.5% were grandparents. Among the participants, 780 (70.2%) were willing to vaccinate their children against PCV13, 121 (10.8%) participants were not willing to vaccinate their children against PCV13, and 209 (18.8%) participants were not sure whether to vaccinate children against PCV13. Therefore, 70.2% of participants were identified as PCV13 vaccine recipients and 29.7% were identified as vaccine hesitators.

A total of 308 parents were unwilling to vaccinate their children against PCV13 due to individual and group influences, which accounted for the largest portion (Figure 1). As presented in Table 1, among the vaccine hesitators, 249 people did not know about the vaccine (A1), 92 people were uncertain about the vaccine's effects (C2) and 84 people were uncertain about the safety of the vaccine (C3).

As presented in Table 2, PCV13 vaccine hesitancy among participants who thought vaccination was important was significantly lower than among those who thought vaccination was not important (28.5% *vs.* 64.1%, $P<0.001$). PCV13 vaccine hesitancy among participants who were willing to pay for the PCV13 vaccine also was significantly lower than among those who were not willing to pay (19.6% *vs.* 55.6%, $P<0.001$). Participants who could clearly distinguish between the PCV13 vaccine and the COVID-19 vaccine were less hesitant toward the PCV13 vaccine (25.2% *vs.* 39.9%, $P<0.001$).

The statistically significant variables in Table 2 were incorporated into the logistic multi-factor regression model for further analysis. As presented in Table 3, the participants who were not willing to pay for the PCV13 vaccine for their children [*OR*=3.85, 95% confidence interval (*CI*): 2.81–5.25)], who thought vaccination was not important (*OR*=3.54, 95% *CI*: 1.66–7.56), and who were not willing to pay for all self-funded vaccines (*OR*=1.98, 95% *CI*: 1.35–2.93)

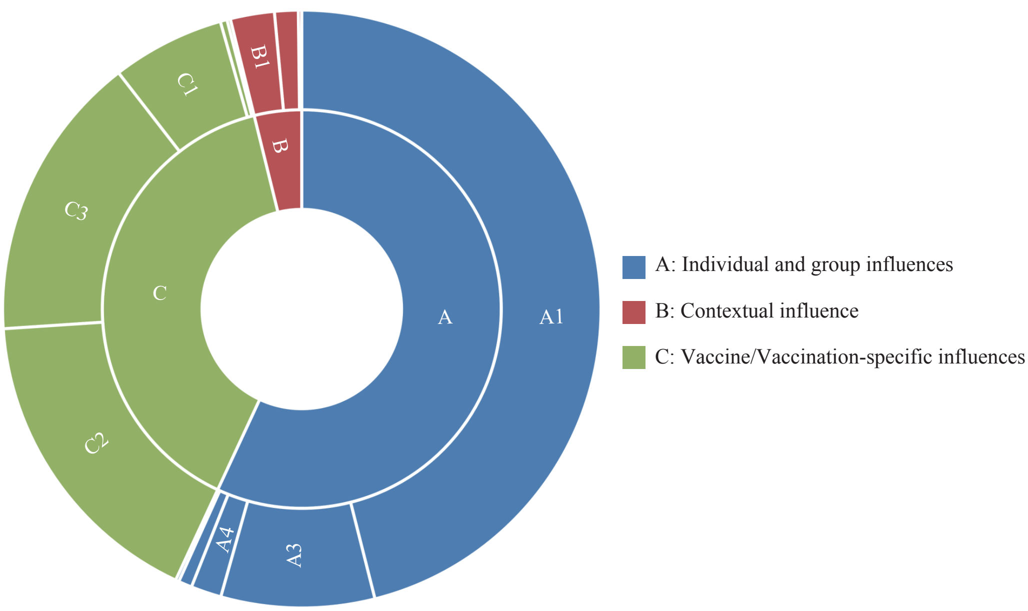


FIGURE 1. Reasons of hesitancy in 13-valent pneumococcal conjugate vaccines in Weifang, Shandong Province, China.

TABLE 1. Distribution of reasons for 13-valent pneumococcal conjugate vaccine hesitancy among study participants in Weifang City, Shandong Province, China.

Reason	No. of participants	Proportion (%)
A: Individual and group influences		
A1: I don't know much about 13-valent pneumococcal conjugate vaccine	249	75.5
A2: I don't know where to get 13-valent pneumococcal conjugate vaccine	1	0.3
A3: The children are healthy and do not need the 13-valent pneumococcal conjugate vaccine	45	13.6
A4: Children with allergies or contraindications cannot receive the 13-valent pneumococcal conjugate vaccine	9	2.7
A5: Children were considered too young to receive the 13-valent pneumococcal conjugate vaccine	4	1.2
B: Contextual influences		
B1: Participants' work schedule or traveling distance from home to vaccination clinic prevent them from having their children receive the 13-valent pneumococcal conjugate vaccine	13	3.9
B2: Whether children should receive the 13-valent pneumococcal conjugate vaccine should be discussed with family members	7	2.1
B3: Participants are not willing to pay the vaccination fee on their own	1	0.3
C: Vaccine/vaccination-specific influences		
C1: The 13-valent pneumococcal conjugate vaccine is expensive	33	10.0
C2: The efficacy of 13-valent pneumococcal conjugate vaccine is uncertain	92	27.9
C3: The safety of 13-valent pneumococcal conjugate vaccine is uncertain	84	25.5
C4: The 13-valent pneumococcal conjugate vaccine is not included in the immunization program	2	0.6
C5: The 13-valent pneumococcal conjugate vaccine is not mandatory	1	0.3

Note: The study used multiple-choice questions to analyze the reasons for vaccine hesitancy, so the sum of these three categories was not 100%.

TABLE 2. Characteristics of 1,110 participants in the 13-valent pneumococcal conjugate vaccine hesitancy study in Weifang City, Shandong Province, China.

Characteristic	*N* (%)	PCV13 vaccine hesitancy				χ^2	*P*
		Yes		No			
		N	%	*N*	%		
Relationship between participant and child							
Mother	677 (60.9)	198	29.2	479	70.8		
Father	394 (35.4)	117	29.7	277	70.3	1.499	0.473
Grandparent	39 (3.5)	15	38.5	24	61.5		
Participants' medical education background							
Yes	142 (12.7)	38	26.8	104	73.2	0.687	0.407
No	968 (87.2)	292	30.2	676	69.8		
Participants' age (years)							
≤30	454 (40.9)	115	25.3	339	74.7		
31–40	579 (52.1)	187	32.3	392	67.7	7.655	0.022
≥41	77 (6.9)	28	36.4	49	63.6		
Participants' education level							
Elementary school and below	23 (2.0)	12	52.2	11	47.8		
Junior high school	256 (23.0)	92	35.9	164	64.1		
High school/technical school/technical secondary school	271 (24.4)	88	32.5	183	67.5	18.619	0.001
Junior college/bachelor's degree	529 (47.6)	132	25.0	397	75.0		
Graduate degree	31 (2.7)	6	19.4	25	80.6		

TABLE 2. (Continued)

Characteristic	N (%)	PCV13 vaccine hesitancy				χ^2	P
		Yes		No			
		N	%	N	%		
Children's gender							
Male	585 (52.7)	176	30.1	409	69.9	0.075	0.793
Female	525 (47.2)	154	29.3	371	70.7		
Type of family							
Single child family	472 (42.5)	121	25.6	351	74.4	6.589	0.012
Non-single child family	638 (57.4)	209	32.8	429	67.2		
Average annual family income (CNY)							
<50,000	207 (18.6)	81	39.1	126	60.9	14.431	0.001
50,000–150,000 (not contained)	669 (60.2)	196	29.3	473	70.7		
≥150,000	234 (21.0)	53	22.6	181	77.4		
Number of family members							
≤3	232 (20.9)	56	24.1	176	75.9	4.390	0.036
≥4	878 (79.0)	274	31.2	604	68.8		
Religious belief							
Conflict	6 (0.5)	1	16.7	5	83.3	0.493	0.676
No conflict	1,104 (99.4)	329	29.8	775	70.2		
High importance of vaccination							
Yes	1,071 (96.4)	305	28.5	766	71.5	22.859	<0.001
No	39 (3.5)	25	64.1	14	35.9		
High safety of domestic vaccines							
Yes	1,010 (90.9)	298	29.5	712	70.5	0.271	0.647
No	100 (9.0)	32	32.0	68	68.0		
High safety of imported vaccines							
Yes	559 (50.3)	138	24.7	421	75.3	13.708	<0.001
No	551 (49.6)	192	34.8	359	65.2		
High efficacy of domestic vaccines							
Yes	1,005 (90.5)	289	28.8	716	71.2	4.820	0.028
No	105 (9.4)	41	39.0	64	61.0		
High efficacy of imported vaccines							
Yes	660 (59.4)	163	24.7	497	75.3	19.738	<0.001
No	450 (40.5)	167	37.1	283	62.9		
Trust in vaccine-related information provided by doctors or nurses							
Yes	1,048 (94.4)	301	28.7	747	71.3	9.132	0.003
No	62 (5.5)	29	46.8	33	53.2		
Willingness to take children for self-funded vaccinations							
Yes	940 (84.6)	234	24.9	706	75.1	68.712	<0.001
No	170 (15.3)	96	56.5	74	43.5		
Attitudes to the degree of harm to children's health caused by pneumonia							
Serious	1,054 (94.9)	300	28.5	754	71.5	19.041	<0.001
General	44 (3.9)	26	59.1	18	40.9		
Light	12 (1.0)	4	33.3	8	66.7		

TABLE 2. (Continued)

Characteristic	*N* (%)	PCV13 vaccine hesitancy				χ^2	*P*
		Yes		No			
		N	%	*N*	%		
Risk of pneumonia in children							
Serious	601 (54.1)	138	23.0	463	77.0	33.350	<0.001
General	343 (30.8)	119	34.7	224	65.3		
Light	166(14.9)	73	44.0	93	56.0		
Whether the pneumococcal vaccine is COVID-19 vaccine							
Yes or unknown	343 (30.9)	137	39.9	206	60.1	24.779	<0.001
No	767 (69.0)	193	25.2	574	74.8		
Willingness to vaccinate your child with PCV13 if you pay your own expenses							
Yes	799 (71.9)	157	19.6	642	80.4	138.702	<0.001
No	311 (28.0)	173	55.6	138	44.4		
Whether your children had pneumonia before							
Yes	26 (2.3)	6	23.1	20	76.9	0.560	0.454
No	1,084 (97.6)	324	29.9	760	70.1		

Note: As defined by the World Health Organization, a question will be used in the study to assess participants' hesitation about pneumococcal vaccine: "Would you be willing to vaccinate pneumococcal vaccine for your child?" The options are Yes, No, and Not Sure. If participants chose either of the latter two options, they were considered to have vaccine hesitancy.
Abbreviation: PCV13=13-valent pneumococcal conjugate vaccine; CNY=Chinese Yuan.

TABLE 3. Logistic regression analysis of children pneumococcal vaccine hesitancy in Weifang City, Shandong Province, China.

Independent variables	Category	*β*	$S_{\bar{x}}$	Wald χ^2	*P*	*OR* (95% *CI*)
High importance of vaccination	Yes	–				
	No	1.265	0.387	10.692	0.001	3.542 (1.660–7.558)
High efficacy of imported vaccines	Yes	–				
	No	0.346	0.149	5.403	0.020	1.413 (1.056–1.892)
Willingness to take children for self-funded vaccinations	Yes	–				
	No	0.685	0.198	11.934	0.001	1.984 (1.345–2.927)
Risk of pneumonia in children	Serious	–				
	General	−0.218	0.216	1.025	0.311	0.804 (0.527–1.227)
	Light	−0.679	0.205	10.917	0.001	0.507 (0.339–0.759)
Whether the pneumococcal vaccine is COVID-19 vaccine	Yes or Unknown	–				
	No	−0.809	0.154	27.732	<0.001	0.445 (0.329–0.602)
Willingness to vaccinate your child with PCV13 if you pay your own expenses	Yes	–				
	No	1.346	0.159	71.795	<0.001	3.842 (2.814–5.245)

"–" means reference category.
Abbreviation: *OR*=odds ratio; *CI*=confidence interval.

were more likely to be vaccine hesitant.

DISCUSSION

This study found that 29.7% of participants hesitated to vaccinate their children against PCV13, which was lower than the vaccine hesitancy rates found in previous studies investigating varicella vaccine (51.2%), enterovirus 71 inactivated vaccine (33.8%), and HPV vaccine (37.2%) (*5–7*). This finding may be related to effective advertising of the innovative vaccination strategy of Weifang City, Shandong Province. The results showed that the main channels for participants to acquire information about PCV13 were community or hospital advocacy (45.2%), followed by the internet (36.8%), suggesting that participants may have a relatively high understanding of the vaccine due to these advertisements, thus leading to a relatively low degree of vaccine hesitation.

This study shows that the older the participants are, the more likely they are to be hesitant about vaccines, which is contrary to the results of a Swiss study (*8*). This may be related to China's national conditions. The results also showed that participants with a lower cultural degree are more prone to be vaccine hesitant, which was consistent with the research results of Rosso (*9*) but was contrary to the research results of Van (*10*). This may be explained by China's overall level of education. Participants with lower levels of education have fewer opportunities to learn about pneumococcal vaccines and related topics, which makes them more likely to become vaccine hesitant.

The survey also showed that participants were relatively hesitant to pay for the full pneumococcal vaccine fee by themselves. This can be explained by the fact that PCV13 is still a non-immunization program vaccine in China. Previous studies have also shown that non-programmed vaccines experience higher rates of hesitancy than programmed vaccines (*11*). Logistic regression showed that total self-expenditure was the risk factor for participants' PCV13 vaccine hesitation, reflecting the importance of vaccine price in their decisions to vaccinate.

Globally, 2 to 3 million deaths from infectious diseases can be prevented by vaccination every year. Vaccination is the most cost-effective method for prevention and treatment of infectious diseases. In order to further reduce the burden of pneumococcal diseases in China and similar countries, it is suggested to take the following measures to improve the PCV13 vaccination rate in children:

Carry out multi-channel publicity and vaccine promotion campaigns to improve parental awareness and communicate the importance of PCV13 for children. This study showed that the most important reason for participants' vaccine hesitancy was lack of knowledge about PCV13. Gilkey stated that medical workers can directly influence the vaccination information of children and parents, which can promote vaccination to some extent (*12*). Therefore, publicity channels can focus on medical workers, emphasize the standard training of medical workers, and provide information about the safety and effectiveness of PCV13 to vaccination groups. Secondly, internet platforms can be used to promote PCV13 and PCV13-related knowledge. Fundamental working units can also organize health education activities to make parents aware of the importance of vaccination, so as to further improve parents' awareness of PCV13 and reduce vaccine hesitancy.

Standardize and optimize vaccine management regulations to enhance public confidence regarding the quality and safety of PCV13. In recent years, there have been many incidents of vaccine hesitancy. For example, parents' trust in vaccines declined significantly after the illegal management of vaccines in Jinan in 2016 (*13*). Relevant departments should strictly obey the regulations of the Vaccine Administration Law of the People's Republic of China, strictly supervise the production of vaccines in enterprises, and strengthen the management of all circulation links. It is suggested that government organizations will play an important role in PCV13 vaccination mobilization.

Build the appropriate financial support mechanisms in China to incentivize PCV13 vaccinations effectively and at scale. At present, the price of PCV13 in the Chinese vaccine market is relatively high, which leads to higher vaccine hesitancy (*14*). Therefore, local governments should provide appropriate financial support to reduce the burden of PCV13 vaccination costs for parents. Secondly, it is possible to include PCV13 vaccination costs in the resident medical insurance system and explore different payment modes to promote non-immunization program vaccines. The government can also get the best price for its citizens through centralized bidding processes. PDs have brought a heavy burden of disease to China. In order to solve this problem to the greatest extent, it is suggested to include PCV13 into the national immunization program as soon as possible.

Earlier in 2022, *China CDC Weekly* published an article which analyzed the factors associated with PCV13 vaccine willingness in parents (*3*). Although vaccine willingness and vaccine hesitancy are opposite concepts, they display similar factors. This study further discussed the reasons for participants' concerns about vaccine safety suggested similar interventions to the previously published study. This study also discussed the appropriate financial support mechanisms for society. These two articles are synergistic and complementary.

This study is subject to some limitations. Firstly, this study is based on a cross-sectional survey, so it may not be representative of all of China. Secondly, this study only selected participants from Weifang City, so it needs to be cautious when extrapolating its conclusions to broader contexts. Given that PCV13 is a newly marketed vaccine in China, more epidemiological studies investigating the surveillance of pneumococcal disease risks among pediatric, adult, and elderly populations are required to evaluate the immunization efficacy of PCV13. In addition, safety monitoring of this vaccine is recommended.

Acknowledgments: Weifang Center for Disease Control and Prevention for their contributions; the vaccination clinic doctors of Weifang's 12 counties for patient guidance and help during the investigation; Dr. Heng Du, Xiangbin Wang, and Jie Shan for their technical support of this study. All the volunteers of Weifang Medical University who participated in the survey for nearly a month.

Funding: Supported by Education Foundation of Peking Union Medical College (WH10022021145) and Bill & Melinda Gates Foundation (OPP1 216666).

doi: 10.46234/ccdcw2023.049

Corresponding authors: Jian Zhou, sdwfcdc106@163.com; Chunping Wang, chpwang@163.com; Luzhao Feng, fengluzhao@cams.cn.

[1] School of Public Health, Weifang Medical University, Weifang City, Shandong Province, China; [2] School of Population Medicine & Public Health, Chinese Academy of Medical Sciences/Peking Union Medical College, Beijing, China; [3] Department of Respiratory and Critical Care Medicine, Affiliated Hospital of Guilin Medical University, Guilin City, Guangxi Zhuang Autonomous Region, China; [4] Zhejiang Center for Disease Control and Prevention, Hangzhou City, Zhejiang Province, China; [5] Division of immunization, Center for Disease Control and Prevention, Weifang City, Shandong Province, China; [6] Division of Infectious Diseases, Chinese Center for Disease Control and Prevention, Beijing, China; [7] School of Management, Weifang Medical University, Weifang City, Shandong Province, China; [8] School of Dentistry, University of California Los Angeles, Los Angeles, CA, United States; [9] Division of Infectious Diseases, Center for Disease Control and Prevention, Weifang City, Shandong Province, China.

Submitted: April 06, 2022; Accepted: November 16, 2022

REFERENCES

1. Wahl B, O'Brien KL, Greenbaum A, Majumder A, Liu L, Chu Y, et al. Burden of streptococcus pneumoniae and haemophilus influenzae type b disease in children in the era of conjugate vaccines: global, regional, and national estimates for 2000-15. Lancet Glob Health 2018;6(7): e744 – 57. http://dx.doi.org/10.1016/S2214-109X(18)30247-X.
2. Zhu S, Fang Y, Chang J, Yu JL, Zhang Y, Ji WJ, et al. Investigation on parents' confidence and influencing factors of children's vaccination in Xi'an. In: 2018 Chinese pharmaceutical association pharmaceutical administration professional committee annual meeting and academic symposium proceedings. Ji'nan: Chinese Pharmaceutical Association. 2018; p. 818-27. https://d.wanfangdata.com.cn/conference/ChZDb25mZXJlbmNlTmV3UzIwMjIxMTE3EggxMDIwODQ1MhoINm92ZWlpMXY%3D. (In Chinese).
3. Yang Y, Zhang T, Wang Y, Ma LB, Xie SY, Zhou J, et al. Willingness of caregivers to have their children vaccinated with pneumococcal vaccines in the context of an innovative immunization strategy — Weifang City, Shandong Province, 2021. China CDC Wkly 2022;4(20):421 – 5. http://dx.doi.org/10.46234/ccdcw2022.097.
4. MacDonald NE, SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: definition, scope and determinants. Vaccine 2015;33(34):4161 – 4. http://dx.doi.org/10.1016/j.vaccine.2015.04.036.
5. Liu HY, Zhao TS, Han BF, Du J, Liu YQ, Liu B, et al. A survey of hesitancy of parents to vaccinate children with varicella vaccine in selected areas in 2019. Chin J Vaccines Immun 2021;27(3):302 – 6. http://dx.doi.org/10.19914/j.CJVI.2021056. (In Chinese).
6. Tang ZM, Yu WZ, Liu YM, Feng ZJ. Parental hesitancy to use inactivated enterovirus 71 vaccine and factors influencing hesitancy. Chin J Vaccines Immun 2018;24(3):334 – 8. https://d.wanfangdata.com.cn/periodical/ChlQZXJpb2RpY2FsQ0hJTmV3UzIwMjIxMTE1Eg96Z2pobXkyMDE4MDMwMTYaCHJpZ3E1eGl4. (In Chinese).
7. Xu XF, Yin WQ, Liu M, Li QS, Song YN, Yang CX, et al. The status and influencing factors of mother's HPV vaccine hesitation. Mod Prev Med 2020;47(19):3509-12. https://d.wanfangdata.com.cn/periodical/ChlQZXJpb2RpY2FsQ0hJTmV3UzIwMjIxMTE1Eg94ZHlmeXgyMDIwMTkwMTUaCGRndm91aWE3. (In Chinese).
8. Weiss C, Schröpfer D, Merten S. Parental attitudes towards measles vaccination in the canton of Aargau, Switzerland: a latent class analysis. BMC Infect Dis 2016;16(1):400. http://dx.doi.org/10.1186/s12879-016-1747-0.
9. Rosso A, Massimi A, De Vito C, Adamo G, Baccolini V, Marzuillo C, et al. Knowledge and attitudes on pediatric vaccinations and intention to vaccinate in a sample of pregnant women from the City of Rome. Vaccine 2019;37(14):1954 – 63. http://dx.doi.org/10.1016/j.vaccine.2019.02.049.
10. Van Lier A, Tostmann A, Harmsen IA, De Melker HE, Hautvast JLA, Ruijs WLM. Negative attitude and low intention to vaccinate universally against varicella among public health professionals and parents in the Netherlands: two internet surveys. BMC Infect Dis 2016;16:127. http://dx.doi.org/10.1186/s12879-016-1442-1.
11. Yuen WWY, Lee A, Chan PKS, Tran L, Sayko E. Uptake of human papillomavirus (HPV) vaccination in Hong Kong: facilitators and barriers among adolescent girls and their parents. PLoS One 2018;13(3):e0194159. http://dx.doi.org/10.1371/journal.pone.0194159.
12. Učakar V, Fafangel M, Kraigher A. Vaccine confidence among mothers of young children, Slovenia, 2016. Vaccine 2018;36(37):5544 – 50. http://dx.doi.org/10.1016/j.vaccine.2018.07.062.
13. Qiu J, Hu HJ, Zhou SH, Liu QM. Vaccine scandal and crisis in public confidence in China. Lancet 2016;387(10036):2382. http://dx.doi.org/10.1016/S0140-6736(16)30737-1.
14. Azizi FSM, Kew Y, Moy FM. Vaccine hesitancy among parents in a multi-ethnic country, Malaysia. Vaccine 2017;35(22):2955 – 61. http://dx.doi.org/10.1016/j.vaccine.2017.04.010.

Vital Surveillances

Sentinel Surveillance of Schistosomiasis — China, 2021

Suying Guo[1]; Hui Dang[1]; Yinlong Li[1]; Lijuan Zhang[1]; Fan Yang[1]; Junyi He[1]; Chunli Cao[1]; Jing Xu[1,#]; Shizhu Li[1]

ABSTRACT

Introduction: This report analyzes the national surveillance data for schistosomiasis in 2021 to understand the current status and provide evidence for further policy actions to promote elimination. This analysis is in line with the National Surveillance Plan of Schistosomiasis, which was revised in 2020 to adapt to the new stage of moving towards elimination.

Methods: Data from the 2021 national surveillance of schistosomiasis in humans, livestock, and snails were collected from 13 provincial-level administrative divisions (PLADs) and analyzed using descriptive epidemiological methodology. The antibody-positive rate and area of newly discovered and re-emergent snail habitats were calculated.

Results: In 2021, a total of 31,661 local residents and 101,558 transient population were screened for antibodies using indirect hemagglutination assay (IHA). Of those who tested positive, 745 local residents and 438 transient population underwent further parasitological examination, with only one stool-positive result in the transient population. Additionally, 12,966 livestock were examined using the miracidia hatching test, with no positives detected. The total area of newly discovered and re-emergent snail habitats was 957,702 m^2 and 4,381,617 m^2, respectively. No infected snails were found using the microscopic dissection method, but six pooled snail samples were reported as positive using the loop-mediated isothermal amplification method for detecting specific sequences of *Schistosoma. japonicum*, in Anhui and Jiangxi Provinces.

Conclusions: The prevalence of schistosomiasis among humans and livestock was found to be low, however, a potential transmission risk was identified in certain areas. To reduce the risk of transmission, a comprehensive control strategy should be continued and new techniques should be implemented in the surveillance and early warning system.

Schistosomiasis, one of the 20 neglected tropical diseases listed by the World Health Organization, is classified as a Category B infectious disease and given high priority in China. It is a water-borne infectious disease caused by infection with blood-dwelling flukes of the genus *Schistosoma*. In China, only schistosomiasis japonica, caused by *S. japonicum*, is prevalent, with more than 40 mammals serving as potential definitive hosts (*1*). In the mid-1950s, schistosomiasis japonica was a severe public health issue, with 11.6 million patients and 1.2 million infected cattle (*2*). After 70 years of control interventions, there have been significant decreases in the prevalence and intensity of schistosome infection (*3*). In light of this success and progress, the "Health China 2030" plan has set the goal to eliminate schistosomiasis in all endemic counties, transitioning from transmission control to elimination (*4*).

Since the 1990s, China has implemented a national surveillance project to understand the transmission patterns and trends of schistosomiasis (*5*). In 2020, the National Surveillance Plan of Schistosomiasis was revised and published to adapt to the current status of low endemicity and to identify more settings with potential risk of transmission (*3*,*6*). 2021 was the first year the plan was strictly adhered to. To assess the prevalence and explore areas with potential risk of schistosomiasis transmission, descriptive epidemiological methodology was used to analyze the national schistosomiasis surveillance data from 2021. The results will provide basic evidence for future policy-making and assessments of elimination. Surveillance results showed that infection was rarely found in humans, while no infected livestock was reported. However, potential transmission risk existed in some areas, suggesting that further interventions should be strengthened to consolidate the achievements to date and accelerate the elimination of schistosomiasis.

METHODS

According to the National Surveillance Plan of

Schistosomiasis (version 2020), 455 counties in 13 provincial-level administrative divisions (PLADs) were surveyed, including Anhui, Chongqing, Fujian, Guangdong, Guangxi, Hubei, Hunan, Jiangsu, Jiangxi, Shanghai, Sichuan, Yunnan, and Zhejiang. The counties surveyed were classified into four types based on their transmission status at the end of 2019, as defined by the Criteria of Schistosomiasis Control and Elimination (*7*): Type I, 21 counties at the stage of transmission control; Type II, 263 counties with snails, at the stage of transmission interruption or elimination; Type III, 167 counties with no snails, at the stage of transmission interruption or elimination; and Type IV, 4 counties in the Three Gorges Reservoir area with potential transmission risk of schistosomiasis.

In Type I counties, surveys for infection of schistosomes in local residents, local and imported livestock, and for *Oncomalania hupensis* were conducted in three to five villages that had relatively higher prevalence of schistosomiasis in the previous year. Two to three villages with a high snail burden or with a high risk of snail re-emergence or introduction were selected in each Type II or Type III county to conduct a snail survey, while county-level surveillance on the introduction of snails was conducted in Type IV counties. Additionally, a survey on schistosomiasis in the transient population was conducted in the entire administrative area of counties for all four types, while a survey on imported livestock was only conducted in Type I and Type II counties.

At least 300 local residents from each selected administrative village and 200 of the transient population from each surveillance county were initially screened using the indirect hemagglutination assay (IHA) to detect anti-Schistosoma antibodies in the blood. Those who tested positive were then further examined using the nylon silk bag incubation method (three tests per stool sample) and Kato-Katz method (three slides per stool sample), in parallel, to detect the presence of schistosome eggs or miracidia (*8*). The miracidium hatching test (MHT) was used to detect miracidia in livestock feces. The snail survey was conducted in existing, historical, and likely snail habitats by systematic sampling combined with an environmental sampling method. The collected snails were then investigated by microscopic dissection to identify whether they were alive and infected with schistosomes. The sizes of the snail breeding area, newly developed habitats, and re-emergent habitats, the average percentage of frames with snails (No. of frames with snails / No. of survey frames × 100%), and snail densities were calculated in order to reflect the snail burden (*9*). Additionally, the loop-mediated isothermal amplification (LAMP) method was used to detect schistosome DNA in snails, using pooled samples from selected villages in all Type I and Type II counties which had interrupted the transmission of schistosomiasis in the past five years (*10*).

RESULTS

In 2021, a total of 1,032 villages in 13 PLADs were established as surveillance sites. A total of 31,661 local residents in 21 Type I counties in Anhui, Hunan, and Jiangxi Provinces were screened by IHA, and the positive rate was 2.36% (746/31,661) (Figure 1). Of the 745 antibody-positive individuals, none tested positive for parasites upon parasitological examination.

A total of 101,558 transient individuals in all the

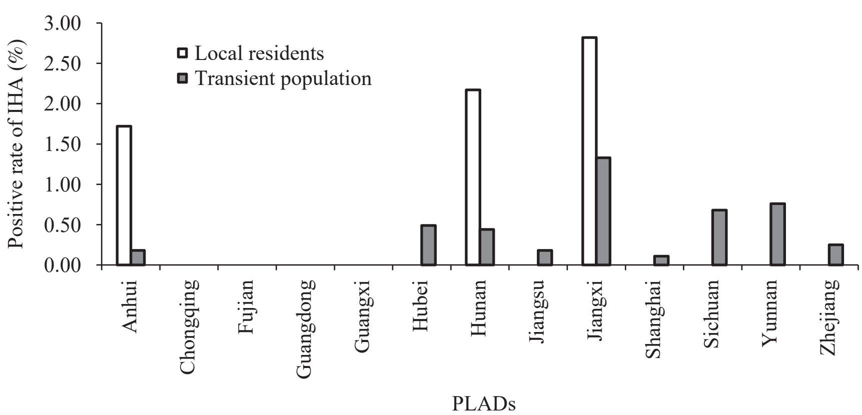


FIGURE 1. Sentinel surveillance results of antibody-positive rate of schistosomiasis using indirect hemagglutination assay (IHA) among local residents and transient population in China in 2021.
Abbreviation: PLADs=provincial-level administrative divisions.

surveillance counties of the 13 PLADs were screened by IHA, yielding a positive rate of 0.44% (442/10,558) (Figure 1). Of the 438 antibody positives, only one positive stool was detected in Zhejiang Province. This individual had traveled in other endemic provinces more than 10 years prior and had been exposed to fresh water near snail-breeding settings.

Except for Chongqing and Shanghai, which had no imported livestock, a total of 12,966 livestock were registered in the administrative regions, with 8,099 local livestock and 4,867 imported livestock in 11 PLADs. In total, 12,698 livestock were examined using the miracidia hatching technique, but no infected livestock was found.

The snail survey was conducted at 1,032 surveillance sites in the 13 PLADs, covering an area of 577,880,171 m^2. Of the snail breeding settings identified, the total area of newly discovered snail habitats was 957,702 m^2, with Anhui Province accounting for 91.37% (Table 1). The total area of re-emergent habitats was 4,381,617 m^2, primarily located in Jiangsu (43.56%), Anhui (32.06%), and Yunnan (13.16%).

Systematic sampling methods were used for the snail survey, and the average percentage of frames with snails was 6.91% (164,064/2,375,916), ranging from 0–15.01% across the 13 PLADs. The average snail density was 0.16 snails per 0.11 m^2 (369,782/2,375,916), ranging from 0–0.41 per 0.11 m^2 across the 13 PLADs. Dissection methodology was used to examine all snails collected by systematic and environmental sampling methods, but no infected snails were found. Additionally, 15,839 pooled samples containing 172,237 living snails were examined by LAMP, and six were reported as LAMP positive, collected from four sites in Anhui province and two sites in Jiangxi Province. No *O. hupensis* snails were found in the Three Gorges Reservoir.

CONCLUSIONS

Compared with the earlier national surveillance plan, the new plan required more extensive surveillance with more mobile sites, and highlighted the importance of snail surveillance, as well as clearly defining the scope and content of risk surveillance (*6*). The prevalence of schistosomiasis in people and livestock remained at a low level. No infected local residents or infected livestock were detected, and only one positive stool sample was diagnosed as an imported

TABLE 1. Sentinel surveillance results of schistosomiasis on *Oncomalania hupensis* in China, 2021.

PLADs	Survey area (m^2)	Area with snails (m^2)	Area of newly discovered snail habitats (m^2)	Area of re-emergent snail habitats (m^2)	Average percentage of frames with snails		Snail density (/0.11 m^2)	LAMP		
					Systematical sampling	Environmental sampling		Number of detected snails	Number of detected mixed samples	Positive samples
Anhui	126,312,082	31,466,975	875,052	1,404,802	9.78	1.76	0.41	37,095	863	4
Chongqing	86,979	0	0	0	-*	-*	0.00	0	0	0
Fujian	1,449,140	117,000	0	103,750	5.10	2.20	0.12	1,107	150	0
Guangdong	1,082,104	0	0	0	-*	-*	0.00	0	0	0
Guangxi	5,372,863	34,730	0	1,746	3.34	0.12	0.07	0	0	0
Hubei	98,212,372	37,461,718	0	0	11.67	0.54	0.25	45,619	1,658	0
Hunan	118,406,880	85,737,019	54,200	101,800	5.05	0.12	0.09	14,867	346	0
Jiangsu	85,754,934	6,161,904	26,700	1,908,807	2.84	0.04	0.06	21,848	671	0
Jiangxi	66,621,838	24,685,971	0	173,825	3.91	0.52	0.09	11,011	355	2
Shanghai	1,529,195	1,960	1750	210	0.17	1.99	0.01	960	25	0
Sichuan	37,862,337	4,356,381	0	64,730	15.01	2.06	0.26	34,287	11,041	0
Yunnan	32,464,835	1,036,788	0	576,603	1.82	0.30	0.06	5,443	730	0
Zhejiang	2,724,613	87,171	0	45,344	2.37	1.53	0.04	0	0	0
Total	577,880,171	191,147,618	957,702	4,381,617	6.91	0.79	0.16	172,237	15,839	6

Note: Average percentage of frames with snails = No. of frames with snails / No. of survey frames × 100%.
Abbreviation: PLADs=provincial-level administrative divisions; LAMP=loop-mediated isothermal amplification.
* No snails were found in Guangdong and Chongqing.

case in the transient population in 2021. These results provide strong evidence that the progress made on schistosomiasis control has been consolidated in the past year, despite the coronavirus disease 2019 (COVID-19) pandemic occurring in all the schistosomiasis-endemic PLADs.

Surveillance of intermediate host snails revealed potential transmission risk. The area of newly discovered and re-emergent snail habitats increased from 1.57 hectares and 338.73 hectares in 2020 to 146.90 hectares and 1442.72 hectares in 2021 (*11*). One of the reasons for the spread and re-emergence of snails was the impact of a catastrophic flood which occurred in 2020 (*12*). Another potential cause may be the difficulties of implementing mollusciciding in extensive snail habitats along the beaches of the Yangtze River and associated major lakes due to the Yangtze River Protection Law of the People's Republic of China. Therefore, future surveillance should be enhanced to understand the dynamic changes of snail population and explore risky areas, to provide reference for implementing appropriate interventions to decrease the transmission risk of schistosomiasis.

No infected snails were identified using the dissection method; however, positive LAMP results were reported from several sites in Anhui and Jiangxi provinces, which may be due to the higher sensitivity of LAMP to detect early or light infection of snails. These results suggest that potential transmission risk of schistosomiasis still exists in natural surroundings. To ensure effective surveillance, more sensitive detection tools should be introduced, given the current low infection rate and intensity as schistosomiasis control moves towards elimination (*13*).

In conclusion, schistosomiasis was characterized by low endemicity in China, with very low prevalence among humans and livestock. To provide evidence for implementing precise interventions, sensitive surveillance should be strengthened, as transmission risk still exists in restricted areas. However, there are some limitations in this study. Surveillance of local residents was only undertaken in counties at the stage of transmission control, which accounted for a small proportion of endemic counties. To understand the infection status of schistosomes in human beings comprehensively, data collection and analysis should be strengthened, as massive population living in endemic areas are screened for schistosomiasis annually in the national schistosomiasis control program. Additionally, the tools used for detecting schistosomes in humans and livestock are parasitological methods with low sensitivity, which may lead to false negatives in infected definitive hosts due to their low infection intensity. Furthermore, sensitive LAMP testing was not stipulated in all county types due to cost considerations, which may result in snails with schistosomes being missed in some risky areas.

To expedite the elimination of schistosomiasis nationwide, surveillance strategies focusing on risk should be enhanced to provide guidance for precise implementation of interventions. Capability building for rapid and effective responses based on multi-sectoral coordination should be strengthened once endemic foci or areas with potential transmission risk have been identified (*14*). Additionally, comprehensive management of snail control should be maintained to consolidate the progress achieved, thus avoiding the rebound and spread of snails under multiple influencing factors, such as floods, large water conservancy projects, and increased human activities. Finally, novel techniques and approaches for diagnosis and detection should be applied and generalized to enhance the efficiency and capacity of the surveillance and early warning system (*15*).

Conflicts of interest: No conflicts of interest.

Acknowledgement: Professionals and staff who contributed to the implementation of national schistosomiasis surveillance in disease prevention and control institutions at all levels in the 13 PLADs.

Funding: Supported by National Science Foundation of China (Grant No. 82073619) and National Key Research and Development Program of China (No. 2021YFC2300800, 2021YFC2300804).

doi: 10.46234/ccdcw2023.050

Corresponding author: Jing Xu, xujing@nipd.chinacdc.cn.

[1] National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention, Chinese Center for Tropical Diseases Research; NHC Key Laboratory of Parasite and Vector Biology; WHO Collaborating Centre for Tropical Diseases; National Center for International Research on Tropical Diseases, Shanghai, China.

Submitted: January 10, 2023; Accepted: March 13, 2023

REFERENCES

1. Xu J, Steinman P, Maybe D, Zhou XN, Lv S, Li SZ, et al. Evolution of the national schistosomiasis control programmes in The People's Republic of China. Adv Parasitol 2016;92:1 – 38. http://dx.doi.org/10.1016/bs.apar.2016.02.001.
2. Zhou XN, Wang LY, Chen MG, Wu XH, Jiang QW, Chen XY, et al. The public health significance and control of schistosomiasis in China-then and now. Acta Trop 2005;96(2 – 3):97 – 105. http://dx.doi.org/10.1016/j.actatropica.2005.07.005.
3. Hong Z, Li L, Zhang LJ, Wang Q, Xu J, Li SZ, et al. Elimination of schistosomiasis japonica in China: from the one health perspective.

China CDC Wkly 2022;4(7):130 – 4. http://dx.doi.org/10.46234/ccdcw2022.024.
4. The Central Committee of the Party of P.R.C., The State Council of P.R.C. The healthy China 2030 plan. Chin J Ophthalmol 2018;54(1):11-22. http://dx.doi.org/10.3760/cma.j.issn.0412-4081.2018.01.004. (In Chinese).
5. Zhang LJ, Li SZ, Wen LY, Lin DD, Abe EM, Zhu R, et al. The establishment and function of schistosomiasis surveillance system towards elimination in the People's Republic of China. Adv Parasitol 2016;92:117 – 41. http://dx.doi.org/10.1016/bs.apar.2016.03.003.
6. Dang H, Li YL, Lv S, Xu J, Li SZ. Interpretation for national surveillance plan of schistosomiasis (version 2020). J Trop Dis Parasitol 2020;18(3):133 – 7. http://dx.doi.org/10.3969/j.issn.1672-2302.2020.03.001. (In Chinese).
7. Zhang LJ, Xu ZM, Dang H, Li YL, Lv S, Xu J, et al. Endemic status of schistosomiasis in People’s Republic of China in 2019. Chin J Schistosomiasis Control 2020;32(6):551 – 8. http://dx.doi.org/10.16250/j.32.1374.2020263. (In Chinese).
8. Li YL, Dang H, Zhang LJ, Li GP, Shan XW, Yuan M, et al. Schistosomiasis surveillance — China, 2015-2018. China CDC Wkly 2020;2(3):39 – 43. http://dx.doi.org/10.46234/ccdcw2020.011.
9. Dai SM, Edwards J, Guan Z, Lv S, Li SZ, Zhang LJ, et al. Change patterns of oncomelanid snail burden in areas within the Yangtze River drainage after the three gorges dam operated. Infect Dis Poverty 2019;8(1):48. http://dx.doi.org/10.1186/s40249-019-0562-4.
10. Qin ZQ, Xu J, Feng T, Lv S, Qian YJ, Zhang LJ, et al. Field evaluation of a loop-mediated isothermal amplification (LAMP) platform for the detection of *Schistosoma japonicum* infection in *Oncomelania hupensis* snails. Trop Med Infect Dis 2018;3(4):124. http://dx.doi.org/10.3390/tropicalmed3040124.
11. Zhang LJ, Xu ZM, Yang F, Dang H, Li YL, Lv S, et al. Endemic status of schistosomiasis in People’s Republic of China in 2020. Chin J Schistosomiasis Control 2021;33(3):225 – 33. http://dx.doi.org/10.16250/j.32.1374.2021109. (In Chinese).
12. Guo SY, Zhu HQ, Cao CL, Deng WP, Bao ZP, Jia TW, et al. Risk assessment of schistosomiasis transmission along the middle and lower reaches of Yangtze River after flooding in 2020. Chin J Parasitol Parasit Dis 2021;39(6):753 – 9. http://dx.doi.org/10.12140/j.issn.1000-7423.2021.06.005. (In Chinese).
13. Lv C, Deng WP, Wang LP, Qin ZQ, Zhou XN, Xu J. Molecular techniques as alternatives of diagnostic tools in China as schistosomiasis moving towards elimination. Pathogens 2022;11(3):287. http://dx.doi.org/10.3390/pathogens11030287.
14. Xu J, Li SZ, Guo JG, Zhou XN, Djirmay AG. The WHO new guideline to control and eliminate human schistosomiasis: implications for the verification of transmission interruption and surveillance of *Schistosoma japonicum* in China. Infect Dis Poverty 2022;11(1):79. http://dx.doi.org/10.1186/s40249-022-01003-w.
15. Gordon CA, Williams GM, Gray DJ, Clements ACA, Zhou XN, Li YS, et al. Schistosomiasis in the People's Republic of China - down but not out. Parasitology 2022;149(2):218 – 33. http://dx.doi.org/10.1017/S0031182021001724.

Indexed by Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), PubMed Central (PMC), Scopus, Chinese Scientific and Technical Papers and Citations, and Chinese Science Citation Database (CSCD)

The inauguration of *China CDC Weekly* is in part supported by Project for Enhancing International Impact of China STM Journals Category D (PIIJ2-D-04-(2018)) of China Association for Science and Technology (CAST).

CCDC weekly

Vol. 5 No. 12 Mar. 24, 2023

Responsible Authority

National Health Commission of the People's Republic of China

Sponsor

Chinese Center for Disease Control and Prevention

Editing and Publishing

China CDC Weekly Editorial Office
No.155 Changbai Road, Changping District, Beijing, China
Tel: 86-10-63150501, 63150701
Email: weekly@chinacdc.cn

CSSN

ISSN 2096-7071
CN 10-1629/R1