**Summary**

What is already known on this topic?
The national program of prevention of mother-to-child transmission (PMTCT) of syphilis was initiated in 2011 and scaled to a national level since 2015. A better understanding of the implementation and outcomes of the program on PMTCT of syphilis is needed for future strategies to achieve the World Health Organization (WHO) goal of elimination of mother-to-child transmission (EMTCT) of syphilis.

What is added by this report

Between 2011 and 2018, as the coverage of syphilis screening of pregnant women and treatment for syphilis-seropositive pregnant women and their infants have increased consistently, the incidence of congenital syphilis was significantly reduced from 91.6 cases per 100,000 live births to 18.4 cases per 100,000. Treatment rates and adequate treatment rates of syphilis-seropositive pregnant women were below the criteria of validation of EMTCT of syphilis and regional disparities were found.

What are the implications for public health practice?

We recommend continuing to strengthen the current PMTCT intervention strategies with further commitments to achieve the targets set by the WHO’s dual EMTCT of HIV and syphilis. Barriers to achieving high coverage of adequate treatment should be investigated and addressed at the provincial level to ensure prompt treatment for syphilis-seropositive pregnant women.

Syphilis caused by *Treponema pallidum* can be transmitted transplacentally from a pregnant woman to her fetus. Without treatment, maternal syphilis is estimated to result in adverse birth outcomes (ABOs) in 50%–80% of affected pregnancies (1). Congenital syphilis (CS) as one of the ABOs can be prevented by early detection of maternal syphilis through testing and prompt treatment to cure maternal and fetal infections (2). The World Health Organization (WHO) launched the global initiative to eliminate mother-to-child transmission (EMTCT) of syphilis in 2007 and integrated interventions of maternal syphilis into the existing elimination of HIV in 2015 (3). Syphilis screening for cases and treatment for infected pregnant women and their infants as a vital component of the national program on preventing mother-to-child transmission (PMTCT) of HIV, syphilis, and HBV has been available freely in China since 2010 and achieved universal coverage since 2015 (4). A better understanding of the implementation and outcomes of the program on PMTCT of syphilis is needed for future strategies to achieve the WHO goal of EMTCT of syphilis. The data from the surveillance systems revealed that there was a marked increase in the coverage of syphilis screening of pregnant women and treatment for syphilis-seropositive pregnant women and their infants in China between 2011 and 2018. Meanwhile, the incidence of CS significantly dropped from 91.6 cases per 100,000 live births to 18.4 cases per 100,000 live births. However, treatment rates and adequate treatment rates of syphilis-seropositive pregnant women were below the criteria of validation of EMTCT of syphilis and regional disparities were found. Hence, the current PMTCT intervention strategies need to be strengthened continuously with further commitments. More effort is needed to remove roadblocks to achieving high coverage of adequate treatment.

The report described the coverage of maternal syphilis screening and treatment for syphilis-seropositive pregnant women and their infants in China using the 2011–2018 national information system of PMTCT of HIV, syphilis, and HBV management data. The national information system of PMTCT of HIV was established in 2007 by the National Center for Women and Children’s Health of China CDC. Since 2011, the system started to collect data on PMTCT of syphilis and HBV. Data on syphilis screening of pregnant women and treatment of syphilis-seropositive pregnant women and their infants was collected through mandatory case-reporting and
Syphilis-seropositive diagnosis required positive results from both types of serologic tests for syphilis: non-treponemal and treponemal. The diagnosis of CS results from both types of serologic tests for syphilis: the proportion of syphilis-seropositive pregnant women among pregnant women who received syphilis test during pregnancy.

### TABLE 1. Testing rates and positive rates of maternal syphilis among pregnant women, China, 2011–2018.

| Year | No. of pregnant women | Syphilis test during pregnancy | Syphilis test predelivery | Syphilis-seropositive pregnant women |
|------|------------------------|-------------------------------|---------------------------|-------------------------------------|
|      |                        | n | %       | n | %       | n | % (95% CI)* |
| 2011 | 8,590,863              | 7,303,093 | 85.0 | 4,084,096 | 47.5 | 14,822 | 2.03 (2.00−2.06) |
| 2012 | 12,061,754             | 11,470,728 | 95.1 | 7,446,927 | 61.7 | 23,101 | 2.01 (1.99−2.04) |
| 2013 | 13,074,271             | 12,597,061 | 96.4 | 8,749,303 | 66.9 | 27,435 | 2.18 (2.15−2.20) |
| 2014 | 13,796,336             | 13,724,595 | 99.5 | 10,481,076 | 76.0 | 31,757 | 2.31 (2.29−2.34) |
| 2015 | 13,983,083             | 13,823,676 | 98.9 | 11,495,493 | 82.2 | 33,279 | 2.41 (2.38−2.43) |
| 2016 | 18,325,702             | 18,223,078 | 99.4 | 16,051,482 | 87.6 | 40,213 | 2.21 (2.19−2.23) |
| 2017 | 17,566,853             | 17,517,666 | 99.7 | 15,971,783 | 90.9 | 46,562 | 2.66 (2.63−2.68) |
| 2018 | 15,132,674             | 15,060,037 | 99.5 | 14,203,528 | 93.9 | 45,985 | 3.05 (3.03−3.08) |
| Total| 112,531,536            | 109,719,934 | 97.5 | 88,483,688 | 78.6 | 263,154 | 2.40 (2.39−2.41) |

* %‰=the proportion of syphilis-seropositive pregnant women who received syphilis test during pregnancy.

During 2011–2018, the number of pregnant women screened for syphilis raised from 7,303,093 to 15,060,037, which indicated a twofold increase. The rates of maternal syphilis screening during pregnancy (predelivery and at labor) and predelivery increased from 85.0‰ (7,303,093/8,590,863) and 47.5‰ (4,084,096/8,590,863) to 99.5‰ (15,060,037/15,132,674) and 93.9‰ (14,203,528/15,132,674), respectively. A total of 263,154 syphilis-seropositive pregnant women had been detected, with a maternal syphilis positive rate of 2.40‰ (95% CI: 2.39‰−2.41‰) between 2011 and 2018. The rate increased from 2.03‰ (95% CI: 2.00‰−2.06‰) to 3.05‰ (95% CI: 3.03‰−3.08‰) (trend $\chi^2 = 3575.84$, $p<0.001$) during the study period. (Table 1)

The treatment rates of syphilis-seropositive pregnant women and the prophylaxis treatment rates of their newborn infants consistently raised during the study period. In 2018, the treatment rate and the prophylaxis rate were 84.3% (29,982/35,578) and 69.5% (24,799/35,671), respectively. Along with increasing uptake of treatment for infected mothers and their infants, the incidence of CS reduced from 91.6 cases per 100,000 live births to 18.4 cases per 100,000 live births between 2011 and 2018. (Figure 1)

Among 31 provincial-level administrative divisions (PLADs) of the mainland of China, the treatment rates of 7 (22.6%) PLADs were higher than 90% and that of 4 (12.9%) PLADs were higher than 95%. None of the provinces achieved an adequate treatment rate of 95% in 2018. Compared with 2017, the treatment rates and the adequate treatment rates of 19 (61.3%) provinces significantly increased ($p<0.05$), but of 2 provinces (Hainan and Qinghai) decreased ($p<0.05$) in 2018. No statistically significant differences were found in 2 rates.
of Beijing, Liaoning, Shanghai, and Jilin between 2017 and 2018. (Table 2)

**DISCUSSION**

This analysis was a comprehensive overview of the national program on PMTCT of syphilis in China since 2011. The findings showed that the overall uptake of PMTCT program continued to increase and reached a high level, and perinatal transmission of syphilis decreased since the initiation of the PMTCT program. But the results showed that the positive rate and the disease burden of maternal syphilis increased yearly, and in 2018 nearly 46,000 syphilis-seropositive pregnant women were detected. The study confirmed that the interventions of PMTCT of syphilis were effective and need to be carried on consistently.

The findings showed that the coverage of syphilis screening among pregnant women increased consistently and was over 99% in 2018. Meanwhile, the rate of hospital delivery was 99.8% in China in 2018. Thus, the program has covered almost every pregnant woman in China. The PMTCT services were integrated with antenatal care (ANC), perinatal care, and child health care in China. The work of the maternal and child health (MCH) network guarantees the implementation of PMTCT services to a high level. As a result, the expansion of the screening coverage was in line with the increasing coverages of ANC and hospital delivery nationwide.

Our results showed that gaps still existed in achieving the national targets of treatment rate of syphilis-seropositive pregnant women and prophylaxis rate of their newborn infants over 90% by 2020. The study also found that the average level of adequate treatment (69.6% in 2018) was below the WHO treatment goal of 95%. Previous studies in China reported that third-trimester syphilis diagnosis, no treatment, or initiation of treatment after 37 weeks of gestation were significantly associated with increased risk of CS, and treatment before the third trimester and adequate treatment were protective factors (7–9). Late diagnosis and initiation of treatment might contribute to low adequate treatment rates and affect the effectiveness of the program. More effort is needed to improve uptake of screening during the first trimester, early diagnosis, and early initiation of treatment for maternal syphilis in the future.

The CS cases are mainly distributed in Xinjiang, Qinghai, Sichuan, Chongqing, and Guizhou in China (10). The result indicated that the rate of treatment in some PLADs with a high number of CS cases were relatively low or had no significant progress between 2017 and 2018. The differences in the program performed at the provincial level might be due to comprehensive factors embedded in the local context. Further studies are needed in PLADS to provide evidence to develop specific strategies to improve the uptake of treatment for maternal syphilis.

The study is subject to at least a few limitations. CS cases reported from the national information system of PMTCT of HIV, syphilis and HBV might be lower than the real figure due to lost follow-ups of infants.
TABLE 2. Treatment rates and adequate treatment rates of syphilis-seropositive pregnant women at the provincial level in China, 2017–2018.

| PLADs       | No. of sero-positive pregnant women | Treatment | Adequate treatment | No. of sero-positive pregnant women | Treatment | Adequate treatment |
|-------------|------------------------------------|-----------|--------------------|------------------------------------|-----------|--------------------|
|             | No. | %     | No. | %     | No. | %     | No. | %     | No. | %     |
| Yunnan      | 1,963 | 1,901 | 96.8 | 1,692 | 86.2 | 1,959 | 1,916 | 97.8 | 1,787 | 91.2 |
| Hunan       | 2,420 | 2,269 | 93.8 | 1,838 | 76.0 | 2,615 | 2,527 | 96.6* | 2,185 | 83.6* |
| Zhejiang    | 2,559 | 2,384 | 93.2 | 2,123 | 83.0 | 2,176 | 2,088 | 96.0* | 1,898 | 87.2* |
| Beijing     | 274  | 255  | 93.1 | 232  | 84.7 | 218  | 209  | 95.9 | 196  | 89.9 |
| Sichuan     | 2,821 | 2,593 | 91.9 | 1,886 | 66.9 | 2,931 | 2,745 | 93.7* | 2,117 | 72.2* |
| Guizhou     | 2,312 | 2,082 | 90.1 | 1,308 | 56.6 | 2,556 | 2,371 | 92.8* | 1,759 | 68.8* |
| Tianjin     | 313  | 205  | 65.5 | 173  | 55.3 | 339  | 307  | 90.6* | 240  | 70.8* |
| Guangdong   | 3,130 | 2,742 | 87.6 | 2,008 | 64.2 | 3,213 | 2,864 | 89.1 | 2,286 | 71.1* |
| Liaoning    | 1,145 | 999  | 87.2 | 912  | 79.7 | 1,220 | 1,069 | 87.6 | 989  | 81.1 |
| Guangxi     | 2,190 | 1,835 | 83.8 | 1,609 | 73.5 | 2,071 | 1,799 | 86.9* | 1,594 | 77.0* |
| Ningxia     | 189  | 139  | 73.5 | 105  | 55.6 | 209  | 180  | 86.1* | 123  | 58.9 |
| Anhui       | 1,803 | 1,386 | 76.9 | 1,164 | 64.6 | 1,684 | 1,442 | 85.6* | 1,247 | 74.0* |
| Shanxi      | 655  | 457  | 69.8 | 306  | 46.7 | 677  | 568  | 83.9* | 421  | 62.2* |
| Xinjiang    | 1,151 | 886  | 77.0 | 723  | 62.8 | 1,182 | 973  | 82.3* | 843  | 71.3* |
| Jiangsu     | 1,817 | 1,400 | 77.1 | 1,170 | 64.4 | 1,885 | 1,537 | 81.5* | 1,336 | 70.9* |
| Hainan      | 321  | 295  | 91.9 | 186  | 57.9 | 162  | 129  | 79.6* | 75   | 46.3* |
| Chongqing   | 841  | 607  | 72.2 | 479  | 57.0 | 773  | 602  | 77.9* | 512  | 66.2* |
| Jiangxi     | 717  | 531  | 74.1 | 341  | 47.6 | 716  | 554  | 77.4 | 406  | 56.7* |
| Shanghai    | 436  | 313  | 71.8 | 243  | 55.7 | 365  | 282  | 77.3 | 219  | 60.0 |
| Fujian      | 1,447 | 1,006 | 69.5 | 851  | 58.8 | 1,479 | 1,135 | 76.7* | 1,006 | 68.0* |
| Qinghai     | 273  | 235  | 86.1 | 152  | 55.7 | 424  | 324  | 76.4* | 195  | 46.0* |
| Henan       | 889  | 595  | 66.9 | 308  | 34.6 | 986  | 744  | 75.5* | 475  | 48.2* |
| Hebei       | 639  | 280  | 43.8 | 236  | 36.9 | 794  | 562  | 70.8* | 461  | 58.1* |
| Shaanxi     | 587  | 334  | 56.9 | 238  | 40.5 | 616  | 410  | 66.6* | 322  | 52.3* |
| Heilongjiang | 890  | 529  | 59.4 | 398  | 44.7 | 761  | 499  | 65.6* | 400  | 52.6* |
| Inner Mongolia | 552  | 257  | 46.6 | 172  | 31.2 | 614  | 387  | 63.0* | 292  | 47.6* |
| Hubei       | 589  | 313  | 53.1 | 243  | 41.3 | 624  | 382  | 61.2* | 313  | 50.2* |
| Shandong    | 1,161 | 618  | 53.2 | 420  | 36.2 | 1,400 | 854  | 61.0* | 673  | 48.1* |
| Jilin       | 654  | 379  | 58.0 | 297  | 45.4 | 653  | 389  | 59.6 | 313  | 47.9 |
| Gansu       | 129  | 63   | 48.8 | 35   | 27.1 | 153  | 80   | 52.3 | 60   | 39.2* |
| Tibet†      | NA   | NA   | NA   | NA   | NA   | 123  | 54   | 43.9 | 33   | 26.8 |
| Total       | 34,867 | 27,888 | 80.0 | 21,848 | 62.7 | 35,578 | 29,982 | 84.3* | 24,776 | 69.6* |

Note: Adequate treatment: at least one injection of 2.4 million units of intramuscular benzathine benzylpenicillin at least 30 days prior to delivery.
Abbreviation: PLADs=provincial-level administrative divisions; NA= not available.
* chi-square test statistically significant p<0.05.
† Tibet Autonomous Region starts to report the data in 2018, the data in 2017 was not available.

born to infected mothers or lack of essential laboratory capacities. Hence, we used CS case data from the national STD surveillance system instead. Another limitation is that we could not analyze the screening rates during different trimesters of pregnancy because of a lack of data on gestational weeks of screening.

In conclusion, China has achieved universal coverage of PMTCT of syphilis for all pregnant women.
However, comprehensive interventions need to be further strengthened to improve early screening, early diagnosis, and early initiation of treatment. Barriers to achieving high coverage of adequate treatment should be investigated and addressed at the provincial level to ensure prompt treatment for infected pregnant women.

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