

Estimating the Direct Medical Cost of Syphilis in China

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Abstract

Background

Few studies investigating the direct medical cost of syphilis was conducted in developing countries, including China.

Methods

The main tasks of our study were to estimate the direct medical costs of syphilis in China at subnational level, and to characterize the distribution of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP. Data on medical expenses for syphilis patients diagnosed at Peking Union Medical College Hospital (PUMCH) was used to estimate direct medical cost per case, which was then multiplied by the number of newly reported cases of syphilis in China to yield the absolute medical cost for syphilis. Relative costs, defined as the absolute costs in per million of gross domestic product (GDP), was also calculated. Comparisons of direct medical cost represented as absolute cost and relative cost respectively, in different years and different provincial districts were conducted. Gini index was used to characterize the distribution of syphilis cases and direct medical cost of syphilis at provincial level.

Results

Average cost of patients with follow-up more than 36 month was regarded as the most reasonable estimate of direct medical cost per case, and was obtained as US \$ 134.43 in primary syphilis, US \$ 119.24 in secondary syphilis, US \$ 503.76 in tertiary syphilis and US \$ 97.59 in latent syphilis. Absolute medical cost of syphilis in China increased from US \$ 11.15 million to US \$46.89 million from 2004 to 2016. Relative cost in China increased from 2.85 to 5.26 per million of GDP from 2004 to 2010, and decreased from 5.26 to 3.99 per million of GDP from 2010 to 2016. The largest relative cost was always observed in western region. Between 2009 and 2016, a large relative medical cost was observed in 7 to 9 provinces in western region, 3 to 5 provinces in eastern region, 1 to 4 provinces in central region, 1 to 2 provinces in northeastern region. The level of inequality decreased from 2010 to 2016, and kept a continuously moderate equality from 2012 to 2016.

Conclusion

This study provided a rough estimate of the direct medical costs of syphilis in China and its distribution pattern in 31 Chinese provincial districts. The results highlight that syphilis caused a huge economic burden in China, which distributed disproportionately within provinces. Western region bore a huge and increasing economic burden, while the economic burden in eastern region had once been huge, but tending to decline. Thus, more active and effective control are needed, and strategies on the prevention and control of syphilis be managed according to local conditions.

Background

Syphilis is a common sexually transmitted disease posing considerable threat to both individual and public health. [1–3] Primary and secondary stages of syphilis can be cured by timely and proper treatment; however, untreated syphilis can progress through a series of stages, and cause a number of irreversible and life-threatening complications, including cardiovascular and neurologic involvement. [4–7] Global Burden of Disease Study 2017 estimated that years lived with disability (YLDs) was 8.6 thousand for early syphilis and 64.3 thousand for tertiary syphilis. [8] This disease is more common in low-income and middle-income countries than in high-income countries. [9] China experienced a reemergence of syphilis after the 1980s economic and social reforms, and there was a dramatic rise in cases of syphilis resulting from rapid social change in the past decades. The annual number of new syphilis cases reported in China increased from 11,336 to 438,199 between 1995–2016, [10] and the annual incidence of syphilis increased at high rate as 16.3% between 2004 and 2013. [11] At present, syphilis has become the most commonly reported sexually transmitted infections (STIs) in China. [7, 12]

Previous studies generally concentrated on investigating the economic burden of syphilis in high-income countries. [6, 14–17] Some of them studied on productivity losses, also known as indirect costs, caused by syphilis. [17] The others studied on direct medical cost caused by syphilis. [6, 14–15] However, few studies were conducted in low-income and middle-income countries.[18] The main tasks of

our study were to estimate the direct medical costs of syphilis in China at subnational level, and to characterize the distribution of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP.

Methods

Study Population and Data Collection

We reviewed medical records of all patients with syphilis diagnosed at Peking Union Medical College Hospital (PUMCH) from 2008 to 2018. Demographic characteristics (including age, gender, ethnicity, residence, year and stage of diagnosis) and medical expenses for syphilis (including examination and treatment expenses, were collected for all of these cases.

In this study, we extracted publicly available data collected and reported by the Chinese Centre for Disease Prevention and Control (CDC) from the Public Health Scientific Data website (<http://www.phsciedata.cn/Share/en/index.jsp>). The data for the case number and incidence of syphilis, including primary syphilis, secondary syphilis, tertiary syphilis, latent syphilis and congenital syphilis, at subnational level were used to estimate the direct medical cost of syphilis in China, and to analyze the level of inequality in the distribution of syphilis cases among 31 Chinese provinces. In addition, data for gross domestic product (GDP) in China were also extracted from Government Finance Statistics Yearbook (<http://www.stats.gov.cn/tjsj/ndsj/>), in order to calculate relative costs in parts per million of GDP, and to analyze the level of inequality in the distribution of direct medical cost among 31 Chinese provinces.

The study was approved by the ethics committee of Peking Union Medical College (S-K653).

Role of the funding source

The funders of our study had no role in the study design, data collection, data analysis, data interpretation, writing of the report, or decision to submit the paper for publication. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Statistical analysis

Cost Calculations

This study estimated only the direct medical cost of syphilis, including examination and treatment costs. Given the recommended follow-up for 36 months after treatment from CDC, we calculated the average costs of patients with follow-up periods more than 36 month, which was also regarded as a reasonable estimate of direct medical cost per case by peer review. Then the estimate value was multiplied by the number of newly reported cases of syphilis from CDC national syphilis surveillance system according to different syphilis stages to yield the absolute medical cost for syphilis. Relative costs, defined as the absolute costs in per million of GDP, was also calculated. In addition, to estimate the direct medical cost of syphilis at the province-level, we calculated both absolute and relative costs for syphilis at 31 Chinese provincial districts respectively.

Lorenz curve and Gini index

The Lorenz curve was initially used to characterize the distribution of the wealth among individuals. Recently, it had also been used in public health studies to analyze the level of inequality in the distribution of medical resources, [19] the occurrence of diseases and deaths. [20-22] In the present study, the Lorenz curve was used to characterize the distribution of syphilis cases in 31 Chinese provincial districts in relation to the population, and the distribution of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP. The Lorenz curve is formed by plotting the cumulative distribution of the direct medical cost of syphilis against the cumulative probability distribution of GDP at provincial level. The line of equality (i.e., the diagonal line) represents even distribution of the direct medical cost of syphilis in relation to GDP in 31 Chinese provincial districts. The more the Lorenz curve bends away from the line of equality, the more unequal the distribution. The Gini index is equal to the area between the Lorenz curve and the diagonal line, divided by the triangle below the equality line. [23] Gini index (G) can be calculated as follows: [24]

$$G = 1 - \sum_{i=0}^{k-1} (Y_{i+1} + Y_i)(X_{i+1} - X_i)$$

In the above equation, Y_i , X_i , and κ show the cumulative share of the number of syphilis cases (or the direct medical cost of syphilis) in the i th province, cumulative share of population (or GDP) in the i th province, and total number of provinces in the present study, respectively. The values of Gini index range from 0 (perfect equality) to 1 (maximum amount of inequality). The values of the Gini index under 0.2 indicate perfect equality, values between 0.2–0.3 represent moderate equality in the distribution, values between 0.3–0.4 show inequality, values between 0.4–0.6 indicate high inequality, and values greater than 0.6 indicate perfect inequality. [25]

The median cost per visit for examination and treatment costs, as well as the average times of examination and treatment per case were analyzed by age, gender, and syphilis stage. To compare with previous studies abroad, all of the costs were calculated with the exchange rate exchange rate of 1 CYN = 0.15055 US \$ in 2016. All statistical analysis was performed using SAS Software 9.4 (SAS Institute Inc., Cary, NC) and Microsoft Excel 2010. Maps and graphs were drawn by ArcGIS Map. 4.0 and R version 3.6.1 software, respectively.

Result

Estimated direct medical cost per syphilis case

There were 3767 patients with syphilis diagnosed at PUMCH from 2008 to 2018, whose demographic features were presented in Table 1. Among 3767 patients, 1749 patients (46.81%) received treatment in our hospital, including only three cases of congenital syphilis (Table 1). The median and extreme value of costs for examination and treatment were characterized by age, gender, and syphilis stage (Table 1). The highest median value of total cost was obtained in tertiary syphilis (US \$ 186.14), followed by congenital syphilis (US \$ 96.92), secondary syphilis (US \$ 56.87), primary syphilis (US \$ 48.99), and latent syphilis (US \$ 46.74). To avoid underestimating of direct medical cost per syphilis case, only the data about direct medical costs in 1746 patients, including primary syphilis (n=151), secondary syphilis (n=518), tertiary syphilis (n=50) and latent syphilis (n=1027), was used to estimate direct medical cost per syphilis case according to different syphilis stage. The data about direct medical costs in three cases of congenital syphilis were excepted due to such a small sample size. Based on 36 months follow up, the estimated average costs per case was obtained as US \$ 134.43 in primary syphilis, US \$ 119.24 in secondary syphilis, US \$ 503.76 in tertiary syphilis and US \$ 97.59 in latent syphilis. (Table s1)

Distribution of syphilis cases in China

In 2016, there were 438199 cases newly reported in China. The highest yearly incidence of total syphilis was reported in Xinjiang (89.05 cases per 100 000), followed by southeast coast area (48.73-62.16 cases per 100 000), including Zhejiang, Shanghai, Fujian, Hainan and Guangdong, and western regions (48.47-56.70 cases per 100 000), including Ningxia, Qinghai and Chongqing (Figure s1). Lorenz curve in Figure s2a showed the distribution of syphilis cases in 31 Chinese provincial districts in relation to the population in each district in 2016. The X-axis represents the cumulative proportion of the population of each provincial district, and the Y-axis is the corresponding cumulative percentage of the number of syphilis cases. Each line segments between adjacent marked points along the Lorenz curve represents a single province, ordered by ascending syphilis incidence. About 21% of the syphilis occurred in the 10% of the population in southeast coast area and western regions. The value of the Gini index of the number of syphilis cases in 31 Chinese provincial districts in relation to the population in each district in 2016 was 0.27, indicating moderate equality in the distribution of syphilis cases.

Yearly incidence of syphilis in China rapidly increased from 7.12 to 30.44 per 100000 persons from 2004 to 2012, and slowly increased from 30.44 to 31.97 per 100000 persons from 2012 to 2016 (Figure s2b). The value of the Gini index of the number of syphilis cases in 31 Chinese provincial districts in relation to the population in each district continuously decreased from 0.52 to 0.27 from 2004 to 2013, and stabilized around 0.27 from 2013 to 2016 (Figure s2b). The value of the Gini index ranged from 0.52 to 0.42 from 2004 to 2009, indicating high inequality in the distribution of syphilis cases, 0.39 to 0.35 from 2010 to 2011, indicating inequality in the distribution of syphilis cases, and 0.29 to 0.27 from 2012 to 2016, indicating moderate equality in the distribution of syphilis cases.

Distribution of economic burden caused by direct medical cost of syphilis in China

The estimated absolute and relative directed medical costs of syphilis except for congenital syphilis were US \$ 46.89 million and 3.99 per million of GDP, respectively, in China in 2016. The estimated absolute and relative directed medical costs in 31 Chinese provincial districts in 2016 were mapped in Figure 1A and 1B, respectively. Among 31 Chinese provincial districts, Guangdong had the largest absolute cost for syphilis (US \$ 5.49 million), followed by eastern regions, including Zhejiang (US \$ 3.73 million), Jiangsu (US \$ 2.69

million), and Anhui (US \$ 2.49 million). However, the largest relative cost as percentage of GDP was observed in Xinjiang (15.78 per million of GDP), followed by western regions (6.14-7.86 per million of GDP), including Ningxia, Yunnan, Qinghai, Xizang, Chongqing and Guizhou, and Hainan (7.80 per million of GDP) and Anhui (6.78 per million of GDP).

Bubble chart was drawn to present the relative medical cost of syphilis in 31 Chinese provincial districts from 2004 to 2016. (Figure 2) The largest relative cost as percentage of GDP was always observed in western region (i.e., Guangxi or Xinjiang) from 2004 to 2016. Between 2009 and 2016, a yearly relative medical cost more than 5.01 per million of GDP was observed in 7 to 9 provinces in western region, 3 to 5 provinces in eastern region, 1 to 4 provinces in central region, 1 to 2 provinces in northeastern region. By 2016, the relative cost had been tending to decline in all of the provinces in eastern and northeastern regions, except for Shandong, Hebei, Hainan and Liaoning. However, no downward trends of the relative cost had been observed in more than half of the provinces in western and northeastern regions. Lorenz curve in Figure 3a showed the distribution of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district in 2016. The X-axis represents the cumulative proportion of the GDP of each provincial district, and the Y-axis is the corresponding cumulative percentage of the direct medical cost of syphilis. Each line segments between adjacent marked points along the Lorenz curve represents a single province, ordered by ascending relative costs, which were defined as the direct medical cost in per million of GDP. About 20% of the direct medical cost of syphilis occurred in certain regions with only 10% of the GDP. The value of the Gini index of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district in 2016 was 0.27, indicating moderate equality in the match between direct medical cost of syphilis and GDP.

Absolute medical cost of syphilis in China increased from US \$ 11.15 million to US \$46.89 million from 2004 to 2016. Relative cost in China increased from 2.85 to 5.26 per million of GDP from 2004 to 2010, and decreased from 5.26 to 3.99 per million of GDP from 2010 to 2016. (Table s2 and Figure 3b) The value of the Gini index for the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district decreased from 0.40 to 0.25 from 2004 to 2014, and slowly increased from 0.25 to 0.27 from 2014 to 2016. (Table s2 and Figure 3b) The value the Gini index was 0.40 in 2004, indicating high inequality in the match between direct medical cost of syphilis and GDP, and ranged from 0.33 to 0.40 (0.399 in 3 decimal places) between 2005 and 2011, indicating inequality in the match between direct medical cost of syphilis and GDP, and 0.25 to 0.27 between 2012 and 2016, indicating moderate equality in the match between direct medical cost of syphilis and GDP.

Discussion

This study is not only the first to estimate the direct medical cost at subnational levels in China over the years, but the first to utilize Lorenz curve and Gini index to analyze the level of inequality in the distribution of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP. Both absolute medical cost and relative medical cost of syphilis in China increased from 2004 to 2010, which was mainly caused by the rapid increase of the newly reported number of syphilis cases. From 2010 to 2016, however, relative medical cost decreased, although the absolute medical cost increased, which was likely to be result from the rapid increase of GDP.

The subnational estimates in 2016 revealed a moderate equality in economic burden distribution within provinces. Southeastern regions, including Guangdong, Zhejiang, Jiangsu and Anhui had larger absolute cost for syphilis owing to their larger diseased population than other regions. However, Xinjiang had the highest relative economic burden as percentage of GDP, due to the highest incidence and lower GDP per capita. Western regions, Hainan and Anhui, with only 10% of the GDP, had about 20% of the direct medical cost of syphilis. These regions had higher relative cost than others may due to high incidence of syphilis and (or) underdevelopments. Economic burden distributed disproportionately within provinces. The largest relative cost was always observed in western region, and most of the provinces in western region had a yearly relative medical cost more than 5.01 per million of GDP between 2009 and 2016. In addition, no downward trends of the relative cost had been observed in more than half of the provinces in western regions. These results suggest that western region bore a huge and increasing economic burden. Certain provinces in southeastern region had large relative medical cost during peak periods. The relative cost had been tending to decline in most of the provinces in eastern region. These results suggest that the economic burden in eastern region had once been huge, but tending to decline. In China, the syphilis patients generally showed poor compliance in follow-up. [18] For example, standardized follow-up for early syphilis last for 24 or 36 years after 3 times of weekly penicillin treatment, [18, 26] however, the average follow-up times were only 19 months in our patients with primary syphilis and secondary syphilis. In a previous study conducted in China, 18 authors calculated the average direct cost per patient based on the assumptions that each patient finished the 3 times of weekly treatment and 0.29 follow-up visits, [27] and revealed a lower average direct cost per case of early syphilis (US \$23.74) than that of our study, which might be caused by the difference of follow-up period and the composition of direct cost between these two studies. In this study, average cost of patients with follow-up more than 36 month was

regarded as the most reasonable estimate of direct medical cost per case, which effectively avoided the underestimation of average direct medical cost caused by the higher rate of loss of follow-up. The direct medical cost per case estimated in this study was US \$ 134.43 in primary syphilis and US \$ 119.24 in secondary syphilis, which was consistent with values of early syphilis (range from US \$53 to US \$512 per case) reported by a number of previous studies conducted in the United States. [6, 28] The direct medical cost per case for tertiary syphilis estimated in this study was US \$ 503.76, far below the values (range from US \$1629 to 84,607 per case) reported in the United States. [28]

Some limitations indeed existed in this study. Firstly, there were potential biases in estimating the direct medical cost of syphilis in national wide by using the estimated value of direct medical cost of syphilis in a single medical center. However, the nationally uniform treatment and follow-up strategies and nationally uniform price of related drugs and laboratory tests, thus, it's rational to ignore these potential biases. Secondly, the economic burden of syphilis was estimated conservatively, because it represented only the direct medical cost of syphilis, but ignored other parts of economic burden, such as direct non-medical cost, indirect economic burden and intangible cost. However, despite that, syphilis caused a huge economic burden that should not be overlooked in China. Then, the direct medical cost of syphilis in national wide was underestimated, because reported number of congenital syphilis was not included. Lastly, there were some biases in increase of reported number of syphilis cases in China, which were introduced by the increasing case-reporting and expanding screening for syphilis for years. [3] Thus, the real increase in total direct medical cost might be exaggerated based on the analyses of notifiable infectious diseases incidence from the national Chinese reporting database.

Conclusions

This study provided a rough estimate of the direct medical costs of syphilis in China and its distribution pattern in 31 Chinese provincial districts. The results highlight that syphilis caused a huge economic burden in China, which distributed disproportionately within provinces. These findings not only helped to assess the economic impact of syphilis on the Chinese people, but also contributed to the data about the direct medical cost of syphilis in developing country. Given the reported disease burden of syphilis in China were increasing year by year, [29] the economic burden born by syphilis patients could no longer be ignored. Thus, more active and effective control (such as partner notification; screening of syphilis in high-risk populations, such as men who have sex with men, commercial sex workers, injection drug users, and STI clinic attendees) and prevention program for syphilis, as well as more studies investigating the direct medical cost of syphilis in developing countries are needed. In addition, strategies on the prevention and control of syphilis be managed according to local conditions because of the uneven distribution of economic burden.

Abbreviations

PUMCH: Peking Union Medical College Hospital

GDP: gross domestic product

YLD: years lived with disability

STI: sexually transmitted infections

CDC: Centre for Disease Prevention and Control

Declarations

Ethics approval and consent to participate

The study was approved by the ethics committee of Peking Union Medical College (S-K653).

Consent for publication

Not applicable.

Availability of data and material

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

XW and JL had full access to all of the data in the study and takes responsibility for the integrity of the data. JL, KRH and XW participated in study concept and design, interpreted results and supervision. All authors participated in data collect. XW, HZG and KRH did the statistical analysis. JL and HZG wrote the draft report. All authors revised the report and approved the final version before submission.

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Tables

Table 1. Direct medical cost of 1749 syphilis patients with treatment										
	N	Total costs (US \$)			Examination costs (US \$)			Treatment costs (US \$)		
		Median	Extreme minimum	Extreme maximum	Median	Extreme minimum	Extreme maximum	Median	Extreme minimum	Extreme maximum
Age										
00-04	3	44.99	5.12	232.39	32.15	0.00	166.19	12.85	5.12	66.21
05-09	3	80.65	39.24	81.56	60.16	36.22	70.73	9.92	3.02	21.40
15-19	54	44.00	1.57	239.10	37.48	0.00	174.24	5.10	1.49	127.60
20-24	176	46.28	1.57	720.89	34.22	0.00	251.94	5.23	1.49	704.67
25-29	269	52.27	1.57	401.18	40.59	0.00	217.92	5.23	1.49	270.97
30-34	228	62.14	1.49	292.37	45.63	0.00	261.82	5.23	1.49	229.91
35-39	171	58.07	1.57	919.10	39.74	0.00	398.36	7.28	1.49	741.03
40-44	169	54.26	1.49	1335.33	42.16	0.00	413.77	5.23	1.49	1122.38
45-49	139	44.64	1.57	1483.48	32.95	0.00	212.11	5.23	1.47	1344.63
50-54	125	50.85	1.57	1596.61	39.41	0.00	375.55	5.59	1.49	1221.47
55-59	103	50.95	1.57	728.55	36.13	0.00	209.67	6.79	1.49	521.97
60-64	96	44.12	1.49	1756.23	33.40	0.00	210.25	5.17	1.49	1621.64
65-69	74	47.41	1.49	1034.45	35.89	0.00	228.92	8.17	1.49	864.74
70-74	71	53.73	1.57	473.08	38.96	0.00	235.86	9.98	1.49	406.52
75-79	33	57.72	11.35	342.94	32.58	0.00	139.07	10.14	1.49	334.83
80-84	22	32.96	1.69	112.16	19.89	0.00	89.13	10.30	1.49	32.36
≥85	13	23.74	9.10	101.25	16.48	7.53	96.23	5.10	1.49	68.19
Sex										
male	877	51.41	1.49	1756.23	38.97	0.00	413.77	5.27	1.47	1621.64
female	872	50.40	1.49	1483.48	39.40	0.00	398.36	5.59	1.49	1344.63
Stage										
Primary	151	48.99	1.57	1483.48	38.96	0.00	413.77	5.23	1.49	1344.63
Secondary	518	56.87	1.49	784.72	43.25	0.00	287.41	6.39	1.49	704.67
Tertiary	50	186.14	16.20	1756.23	58.74	0.00	375.55	116.25	4.53	1621.64
Latent	1027	46.74	1.49	1208.00	35.87	0.00	398.36	5.23	1.47	846.77
Congenital	3	96.92	23.66	232.39	89.99	18.07	166.19	6.93	5.59	66.21
Total	1749	50.95	1.49	1756.23	39.14	0.00	413.77	5.41	1.47	1621.64

Figures

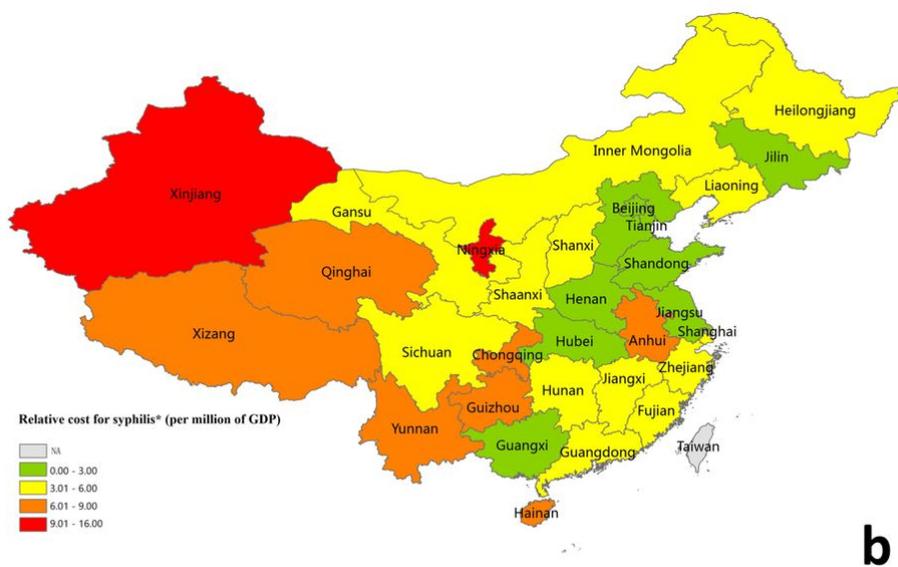
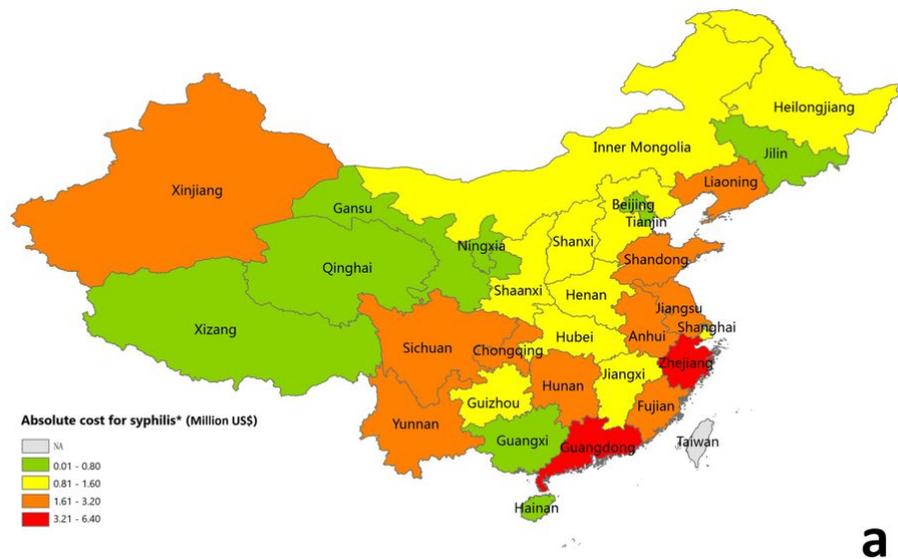


Figure 1

Figure 1

Maps for absolute directed medical costs (panel a) and relative directed medical costs (panel b) in 31 Chinese provincial districts in 2016.

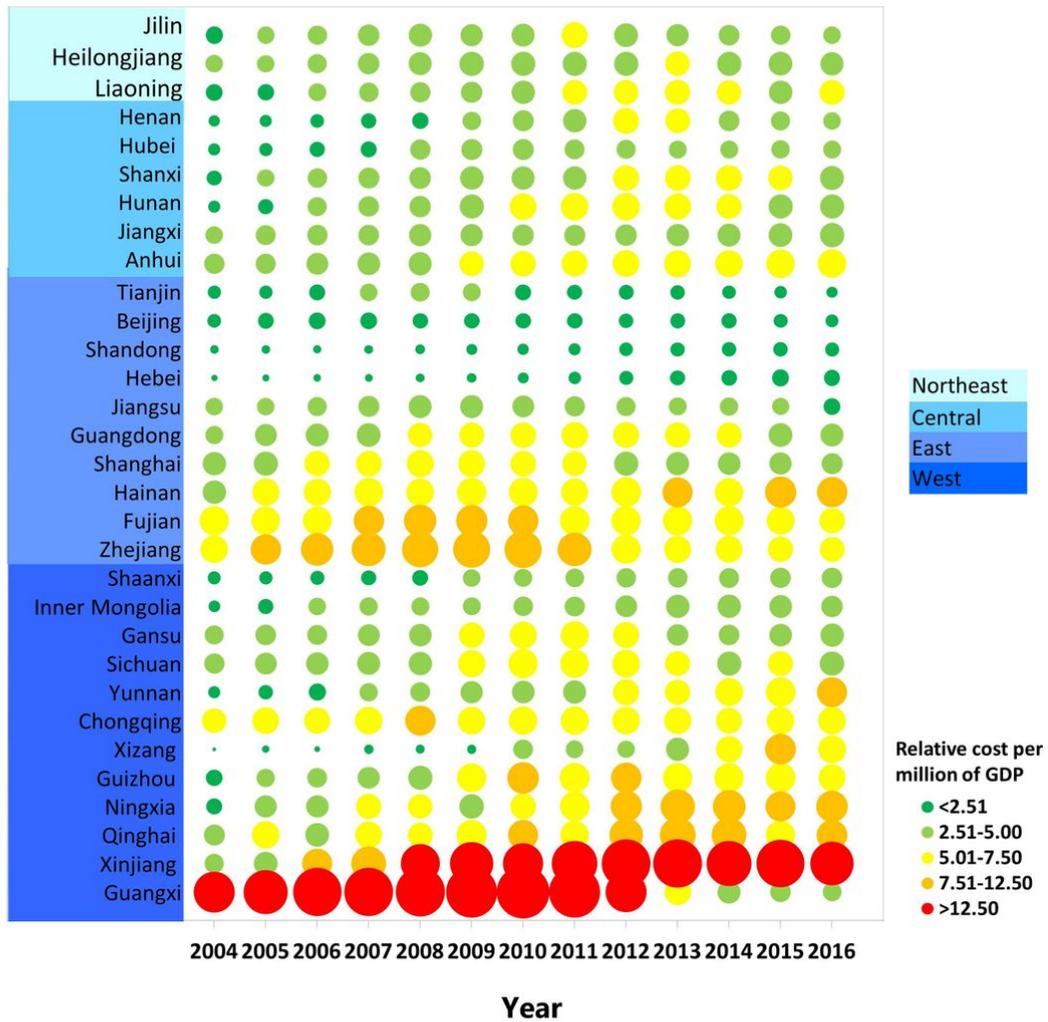


Figure 2

Figure 2

Bubble chart for the relative medical cost of syphilis in 31 Chinese provincial districts from 2004 to 2016. The size of each bubble is a rough indication of the value of the relative medical cost of syphilis.

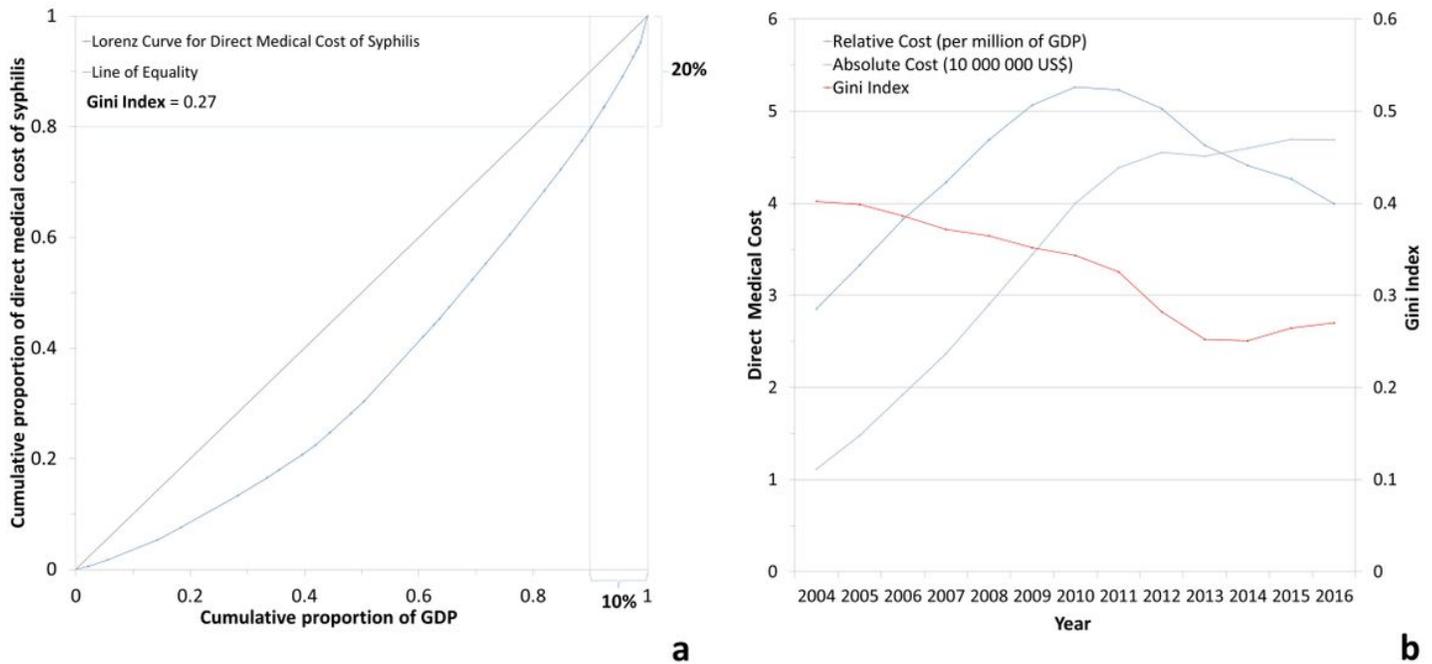


Figure 3

Figure 3

Lorenz curve for the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district in 2016 (panel a) and absolute and relative cost in China and Gini index for the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district from 2004 to 2016 (panel b). As panel a shows, each line segments between corresponding marked points along the Lorenz curve represents a single province, ordered by ascending relative costs, which were defined as the direct medical cost in parts per million of GDP. The line of equality (i.e., the diagonal line) represents even equal distribution of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP. About 20% of the direct medical cost of syphilis occurred in certain regions with only 10% of the GDP. The value of the Gini index of the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district in 2016 was 0.27, indicating moderate equality in the match between direct medical cost of syphilis and GDP. As panel b shows, absolute medical cost of syphilis in China increased from US \$ 11.15 million to US \$46.89 million from 2004 to 2016. Relative cost in China increased from 2.85 to 5.26 per million of GDP from 2004 to 2010, and decreased from 5.26 to 3.99 per million of GDP from 2010 to 2016. The value of the Gini index for the direct medical cost of syphilis in 31 Chinese provincial districts in relation to GDP in each district decreased from 0.40 to 0.25 from 2004 to 2014, and slowly increased from 0.25 to 0.27 from 2014 to 2016. The value the Gini index was 0.40 in 2004, indicating high inequality in the match between direct medical cost of syphilis and GDP, and ranged from 0.33 to 0.40 (0.399 in 3 decimal places) between 2005 and 2011, indicating inequality in the match between direct medical cost of syphilis and GDP, and 0.25 to 0.27 between 2012 and 2016, indicating moderate equality in the match between direct medical cost of syphilis and GDP.

Supplementary Files

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