Equity and efficiency of health resource allocation of Chinese Medicine in mainland China: 2013 to 2017

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Research article

Keywords: TCM health resource, Equity, Efficiency, Productivity

Posted Date: March 13th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-17232/v1

Version of Record: A version of this preprint was published at Frontiers in Public Health on December 15th, 2020. See the published version at https://doi.org/10.3389/fpubh.2020.579269.

Abstract

Background: In this study, we aimed to measure the equity, efficiency and productivity of traditional Chinese medicine (TCM) health resource allocation and utilization in mainland China trend from 2013 to 2017.

Methods: The data were download from the China Health Statistical Yearbook (2018) and the China Statistical Yearbook (2018). The equity and efficiency of TCM health resource allocation was evaluated by Lorenz curve, Gini coefficient (G) and Theil index (T) were applied to evaluate. The efficiency and productivity of TCM health resource utilization were assessed by Data Envelopment Analysis (DEA)-based Malmquist productivity index (MPI).

Results: The TCM health resource had an increasing trend every year. The equity allocated by population (Gs range from 0.1 to 0.3) was better than that by geographic region (Gs more than 0.5). Ts in the intra-groups were higher than that in the inter-groups. Most provinces (29 out of 31) had negative productivity changes, which suggested a deterioration in productivity. However, the middle region with higher scale sizes had more redundant inputs. Moreover, the low technological development (all technical values lower than 1.00) might obstacle the productive progress.

Conclusion: The equity of TCM health allocated by population was better than that by the geography region. The intra-regional difference was the main reasons of the sources of inequity. The equity of TCM resource allocation was middle region eastern region western region. The productivity in more than 97% provinces are inefficient. The frequency distribution of Sech (score 1) increased since 2015. However, the frequency distribution of Techch (score 1) decreased year by year. The slow technological progress and low scale size might the major reason for the low productivity. Keywords: TCM health resource, Equity, Efficiency, Productivity

Introduction

Health resource allocation has been a global issue in the human health service market[1]. The equity and efficiency of health resources distribution are regarded as main goals pursued by the public health management, and also the basic principles advocated by the World Health Organization[2]. Since 1980s, with implementation of market-oriented reform in China, the existing health resources and services cannot meet the rapid economic development and aging population. The inequity, inefficiency and limited insurance coverage of health resources have drawn increasing attention. In 2009, the Chinese Ministry of Health launched an ambitious health care reform program with the goals of universal health coverage for all Chinese by 2020[3]. In the past 10 year, with the deepening reforms on health facilities and public hospitals, zero price policy of medicine and full coverage of basic insurance, considerable progress have achieved in the ongoing of health reform[4, 5]. It was reported that China's healthcare access and quality index was 77.9 in 2016, and ranked 48 out of 195 countries according to the Global Burden of disease Study[6]. However, regional disparities still exists in the health care development[7].

In China, The traditional Chinese medicine (TCM) system is equally important to western medicine system, and plays important roles in the whole health system. TCM, as a unique health resources in China, is a part of our traditional culture. The TCM services included Chinese herb, acupuncture, massage, moxibustion, etc. TCM hospitals are always the main force in health medical care as well as in national medical health services[8]. Since 1949, TCM hospitals (including integrated Chinese and western hospitals, and ethnic medicine hospitals) have made great achievements, and the medical services capability have also improved constantly. However, due to the low charges of TCM services, it is difficulty for its own business to develop. As a result, various equipment and medical facilities are relatively old and slow to update, and the development of new technologies and projects of

TCM has been restricted. Moreover, it costs a long time to train Chinese medicine professionals, and it is difficulty to introduce high-level personnel. The small proportion of TCM talents in TCM hospitals affects the development of the development of TCM hospitals. All the results lead to the low level of medical resources utilization, irrational health resources allocation and low operation efficiency.

Fortunately, along with the promulgation and enforcement of “the traditional Chinese medicine (TCM) law” and “the 13th Five Year Plan of TCM” in 2016, the government increase the investment of the infrastructure construction, deepen the comprehensive reform of TCM hospitals, and train high-level talents. Given the increasing demand of health service, especially traditional Chinese medicine service in China with 1.3 billion population. We tried to use comprehensive indicators including Lorenz curve, Gini coefficients, Theil index, and Data Envelopment Analysis (DEA)-based Malmquist productivity index (MPI) to explore the changes of the TCM health resource allocation and utilization trend from 2013 to 2017. We aimed to provide the reference for government policy decision based on population and geographical structure.

Methods

Data resources and region division

In our study, the data from the China Health Statistical Yearbook (2018) and the China Statistical Yearbook (2018) was collected. The output indicators included outpatient visits and discharged patients, while the input indicators included health staffs, institution and beds numbers. China has 23 provinces, 5 autonomous regions, 4 municipalities and two special administrative areas. In our study, we did not include the data of Hongkong, Macao and Taiwan because of the inconsistent statistical standards. The rest regions are divided into three different regions geographically, that is, the eastern, middle and western regions. The eastern region contains 8 provinces (Heibe, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan) and 3 municipalities (Beijing, Tianjin and Shanghai). The middle region include 8 provinces (Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan). And the western region include 6 provinces (Sichuan, Guizhou, Yunnan, Shaanxi, Gansu and Qinghai) and 5 autonomous regions (Inner Mongolia, Guangxi, Tibet, Ningxia and Xinjiang) and one municipality (Chongqing).

Measuring tools

Lorenz curve was first put forward by a famous economist Lorenz Max Otto[9]. And Gini coefficient was developed by Corrado Gini based on Lorenz curve[10]. Both of them were widely used to determine the equally resource distribution[11–13]. Lorenz curve is a good approach to judge the degree of inequality in the population and geography allocation visually. We used the cumulative proportion of population or geography as the x-axis and the cumulative proportion of three input indicators respectively as the y-axis. The diagonal line of the square was considered as the absolute equality curve.

In view of the Gini coefficient, the value (G) is calculated as the areas between the Lorenz curve and the perfect equality curve, compared with the areas under absolute equality curve. The value is between 0 and 1. The closer the score to 0, the more equitable distribution. On the contrary, the closer the score to 1, the more inequitable distribution. We regard the value less than 0.2 as absolute equality, the value range from 0.2 to 0.3 as relative equality, the value range from 0.3 to 0.4 as proper equality, the value range from 0.4 to 0.5 as relative inequality, and the value above 0.5 as serious inequality[14]. The value is calculated as follows:

Here, X_i represents the relative portions of three input indicators, and Y_i represents the relative proportion of population or geography. κ represents the total numbers of regions in China.

In order to explain the sources of inequality, Theil index is applied to measure the equality. The value (T) range between 0 and 1. The higher the value, the greater inequality the regions will be. The formula[15] of the Theil index is given as follows:

Where P_i is the proportion of the three different regions accounts for the total population. Y_i is the health resources of the three different regions accounts for the total health resources.

The Theil index can be divided into intra-group ($T_{intra-group}$) and inter-group ($T_{inter-group}$)[16]. The formula of them were presented as follows:

Here, t_g means Theil index of three region groups. P_g and Y_g were the same means with P_i and Y_i above.

Due to the Chinese government have more control over the outputs of TCM services than the inputs of health resources, an output-oriented DEA based Banker-Charnes-Cooper (BCC) model and MPI were then chosen to measure the dynamic efficiency of TCM service system in our study. MPI is used to calculate the total factor productivity changes (Tfpch). The Tfpch can be divided into the technical change (Techch) and technical efficiency change (Effch), and the Effch can also be decomposed into pure efficiency (Pech) and scale efficiency (Sech)[17]. All these data were used by DEAP V.2.1 version[18].

Results

The equity of health resource allocation

Changes of health resource allocation based on per 1000 persons and square meters were shown in Table 1. We can see the increasing trend of health resources trend from 2013 to 2017. The average scores of institutions, beds and health staffs in 2013–2017 are 13.69%, 19.58% and 15.31%, respectively.

The Lorenz curves in terms of population and geography from 2013 to 2017 were all drawn. However, we only showed the 2013 and 2017 Lorenz curves (Fig. 1) because of the others have the same trends. From the Lorenz curves (Fig. 1A and C), it showed that the beds and health staffs curves were closer to the absolute equality curve, whereas the institution curves were farther to the absolute equality curve. The results indicated that the beds and health staffs were more equitable than the institution allocated by the population size. As far as the Lorenz curves (Fig. 1B and D), we found that the institution and beds curves were closer to the absolute equality curve, whereas the health staffs curves were farther to the absolute equality curve. These results suggested that the institution and beds were more equitable than the health staffs allocated by the geographical region.

Table 1
Health resource allocation trend from 2013 to 2017

Year	Institution			Beds			Health staffs		
	/1000 persons	/1000 m^2	Total	/1000 persons	/ 1000 m^2	Total	/1000 persons	/1000 m^2	Total
2013	0.0304	0.0436	41,966	0.5836	0.8342	794,160	0.4403	0.6217	599,114
2014	0.0319	0.0453	43,635	0.6414	0.9104	877,255	0.4724	0.6706	646,152
2015	0.0339	0.0483	46,541	0.6966	0.9937	957,523	0.5055	0.7211	694,827
2016	0.0358	0.0514	49,527	0.7475	1.0726	1,033,547	0.5393	0.7739	745,725
2017	0.0390	0.0563	54,243	0.8170	1.1785	1,135,615	0.5731	0.8268	796,704

In view of Gini index from the Table 2, we found that only the Gs of beds and health staffs allocated by population size are less than 0.2. It suggested that they are absolutely equitable. The G of institution in term of population is between 0.2 and 0.3, and it showed a decreasing trend, which indicated that the equity of the institution allocation were improving by years. However, the Gs allocated by geographical region were all more than 0.5, which indicated that the equity of them were worse. The main reasons might be the reginal disparities in different regions (eastern, middle and western). The average number per 1000 $m^2$of institutions in eastern, middle and western regions were 0.1536, 0.072 and 0.027, respectively. The average annual growth rates were 9.47%, 5.29% and 4.99%, respectively. As for beds, the average numbers were 3.3016, 1.7524 and 0.4465, respectively, and the average annual growth rates were 8.46%, 9.25% and 10.52%, respectively. With regard to health staffs, the average numbers were 2.7533, 1.3081 and 0.2589, respectively and the average annual growth rates were 6.41%, 6.87% and 9.72%, respectively.

Table 2
Gini index of health resource by population and geographical region trend from 2013 to 2017

Year	Allocation by population			Allocation by geographical region		
	Institutions	Beds	Health staffs	Institutions	Beds	Health staffs
2013	0.2855	0.1020	0.1080	0.5888	0.6199	0.6751
2014	0.2793	0.1074	0.1090	0.5821	0.6177	0.6738
2015	0.2798	0.1089	0.1080	0.5866	0.6175	0.6710
2016	0.2754	0.1130	0.1028	0.5905	0.6181	0.6661
2017	0.2644	0.1166	0.1024	0.5970	0.6156	0.6671

To further explore the sources of the inequity, the Theil index, intra-groups and inter groups of Theil index were used (Table 3). The results suggested that the intra-regional differences were the main reasons of resources inequity. We further found that the intra-reginal differences mainly due to the intra-region disparities. The contribution rate of intra-health sources (institutions, beds and health staffs) accounted for 99.8%, 94% and 83.5%, respectively. T of every region trend from 2013 to 2017 was presented in Table 4. We found that T of all health resources was the

smallest in middle region and largest in western region. It suggested that it was the most equitable health resource distribution in middle region and the worst equitable allocation in western region. The equity in eastern region was between the middle and western regions. All results indicated that the inequity of TCM resource mainly came from intra-western region.

Table 3
Theil index of health resource trend from 2013 to 2017

Items	2013	2014	2015	2016	2017
Institutions					
T	0.2250	0.2229	0.2266	0.2287	0.2341
$T_{Intra-groups}$	0.2241	0.2226	0.2266	0.2287	0.2336
$T_{Inter-groups}$	0.0009	0.0003	0.0001	0.000	0.0006
Beds					
T	0.1896	0.1909	0.1897	0.1922	0.1922
$T_{Intra-groups}$	0.1763	0.1791	0.1779	0.1812	0.1823
$T_{Inter-groups}$	0.0134	0.0117	0.0117	0.0109	0.0099
Health staffs					
T	0.2386	0.2370	0.2313	0.2278	0.2311
$T_{Intra-groups}$	0.1923	0.1961	0.1933	0.1932	0.1982
$T_{Inter-groups}$	0.0462	0.0409	0.0381	0.0346	0.0329
Outpatient visits					
T	0.2887	0.2911	0.2891	0.2924	0.2912
$T_{Intra-groups}$	0.2082	0.2083	0.2082	0.2120	0.2157
$T_{Inter-groups}$	0.0805	0.0828	0.0808	0.0804	0.0756
Discharged patients					
T	0.2344	0.2307	0.2319	0.2542	0.2299
$T_{Intra-groups}$	0.2222	0.2196	0.2217	0.2441	0.2224
$T_{Inter-groups}$	0.0122	0.0111	0.0101	0.0101	0.0075

Table 4
Theil index of health resource trend from 2013 to 2017

Items	2013	2014	2015	2016	2017
Institutions					
Eastern	0.2117	0.2153	0.2153	0.2357	0.2597
Middle	0.0621	0.0588	0.0646	0.0632	0.0568
western	0.3405	0.3372	0.3341	0.3301	0.3248
Beds					
Eastern	0.1940	0.1966	0.1972	0.2028	0.2086
Middle	0.0859	0.0931	0.0964	0.0973	0.0969
Western	0.2440	0.2421	0.2346	0.2372	0.2333
Health staffs					
Eastern	0.2062	0.2066	0.1996	0.2104	0.2157
Middle	0.0920	0.0985	0.1030	0.0996	0.1034
Western	0.2992	0.3012	0.2937	0.2783	0.2827
Outpatient visits					
Eastern	0.1972	0.1969	0.1967	0.2016	0.2074
Middle	0.0814	0.0865	0.0913	0.0981	0.1007
Western	0.3320	0.3319	0.3251	0.3321	0.3216
Discharged patients					
Eastern	0.2391	0.2400	0.2410	0.3192	0.2459
Middle	0.1362	0.1384	0.1421	0.1374	0.1399
Western	0.2870	0.2748	0.2759	0.2699	0.2721

The efficiency of health resource allocation

From the descriptive statistics trend from 2013 to 2017 (Table 5), we found that both the input and output indicators were increasing year by year. About 19 provinces, 2 autonomous regions and 2 municipalities had decreasing returns to scale. Among of them, four provinces (Shandong, Hunan, Sichuan, Shaanxi) should reduce three inputs (institution, beds and health staffs). Seven provinces (Jiangsu, Anhui, Jiangxi, Henan, Hubei, Guizhou and Yunnan) and one autonomous region (Guangxi) should adjust institutions and beds inputs. Two provinces (Hebei and Gansu) should reduce both institution and health staffs, whereas two provinces (Heilongjiang and Hainan) should adjust both beds and health staffs. Four provinces (Shanxi, Liaoning, Jilin and Fujian) and one autonomous regions (Inner Mongolia) and one municipalities (Chongqing) should adjust health staffs. Moreover, Tianjin and Hebei should not only adjust the inputs but also increase the outputs (Table 6).

Table 5

descriptive statistics of inputs and outputs trend from 2013 to 2017

Year	Items	Inputs			Outputs	
		Institutions	Beds	Health staffs	Outpatient visits	Discharged patients
2013	Max	5,022	59,477	48,249	8,948	1,856,584
	Min	100	1,222	1,346	144	20,765
	Mean	1,354	25,618	19,370	2,613	734,189
2014	Max	5,077	67,265	50,382	9,625	2,049,837
	Min	102	1,489	1,231	171	29,060
	Mean	1,408	28,300	20,883	2,820	818,431
2015	Max	5,280	71,649	53,855	9,791	2,179,909
	Min	115	1,941	1,437	217	33,147
	Mean	1,501	30,888	22,460	2,932	868,214
2016	Max	5,536	77,824	57,168	10,750	2,367,495
	Min	117	1,879	1,546	217	34,610
	Mean	1,598	33,340	24,106	3,104	910,393
2017	Max	5,931	86,064	62,465	11,357	2,719,521
	Min	149	2,193	1,872	249	37,670
	Mean	1,750	36,633	25,761	3,286	1,061,601

Table 6
Slacks of inputs and outputs in 2017

Provinces	Inputs			outputs	
	Institutions	Beds	Health staffs	Outpatient visits	Discharged patients
Beijing	0	0	0	0	0
Tianjin	0	-2948.680	0	14.631	0
Hebei	-243,094.171	0	-485.968	6.912	0
Shanxi	0	0	-1,552.857	0	0
Inner Mongolia	0	0	-1,578.506	0	0
Liaoning	0	0	-882.423	0	0
Jilin	0	0	-710.180	0	0
Heilongjiang	0	-608.632	-331.049	0	0
Shanghai	0	0	0	0	0
Jiangsu	-624,295.457	-13,344.929	0	0	0
Zhejiang	0	0	0	0	0
Anhui	-528,760.717	-12,417.236	0	0	0
Fujian	0	0	-160.221	0	0
Jiangxi	-226,022.560	-3,264.524	0	0	0
Shandong	-608,706.100	-17,189.485	-17.937	0	0
Henan	-758,414.024	-21,243.353	0	0	0
Hubei	-536,501.730	-5,417.382	0	0	0
Hunan	-762,269.571	-19,295.378	-412.403	0	0
Guangdong	0	0	0	0	0
Guangxi	-172,828.226	-5,120.625	0	0	0
Hainan	0	-680.028	-9.715	0	0
Chongqing	0	0	-813.431	0	0
Sichuan	-814,776.018	-4,647.753	-3,037.551	0	0
Guizhou	-222,670.741	-5,438.150	0	0	0
Yunnan	-125,135.601	-1,868.266	0	0	0
Tibet	0	0	0	0	0
Shaanxi	-78,967.758	-11,919.417	-166.413	0	0
Gansu	-27,777.106	0	-440.365	0	0

Provinces	Inputs			outputs	
	Institutions	Beds	Health staffs	Outpatient visits	Discharged patients
Qinghai	0	0	0	0	0
Ningxia	0	0	0	0	0
Xinjiang	0	0	0	0	0

The productivity of health resource allocation

The productivity of health resource allocation was measured by the MPI, as shown in Table 7. The annual mean of Tfpch was 1.006, which showed an increasing trend with 0.6% from 2013 to 2017. The main reason for the increased Tfpch was the increasing of Techch by 0.6%. Besides, we also calculated the MPI of different provinces, autonomous regions and municipalities, as presented in Table 8. We found that only Fujian and Henan went through positive productivity changes (the scores of Tfpch 1.000) trend from 2013 to 2017. However, the others had negative productivity changes, which suggested a deterioration in productivity. Furthermore, the scores of Techch in all provinces, autonomous regions and municipalities were less than 1.000, which indicated the technically inefficient of them.

Table 7
MPI and frequency distribution of health resource allocation by year

Year	Effct	Techch	Pech	Sech	Tfpch
2013–2014	1.000	1.012	1.000	1.000	1.012
2014–2015	1.000	0.985	1.000	1.000	0.985
2015–2016	1.000	1.020	1.000	1.000	1.020
2016–2017	1.000	1.007	1.000	1.000	1.007
Mean	1.000	1.006	1.000	1.000	1.006
Frequency distribution (2013–2014)					
1	13	10	13	10	9
1	4	1	9	4	0
1	14	20	9	17	22
Frequency distribution (2014–2015)					
1	12	4	16	10	5
1	3	0	8	3	0
1	16	27	7	18	26
Frequency distribution (2015–2016)					
1	16	1	8	18	4
1	4	0	10	3	0
1	11	30	13	10	27
Frequency distribution (2016–2017)					
1	21	0	17	20	6
1	3	0	8	3	0
1	7	31	6	8	25

Table 8
MPI of health resource allocation in each provinces

Provinces	Effct	Techch	Pech	Sech	Tfpch
Beijing	1.000	0.942	1.000	1.000	0.942
Tianjin	0.999	0.956	1.001	0.998	0.954
Hebei	1.036	0.945	1.023	1.013	0.979
Shanxi	1.024	0.953	1.013	1.010	0.975
Inner Mongolia	0.989	0.967	1.005	0.984	0.957
Liaoning	0.997	0.955	0.989	1.007	0.952
Jilin	1.013	0.951	1.002	1.010	0.964
Heilongjiang	0.987	0.953	0.982	1.005	0.941
Shanghai	1.000	0.982	1.000	1.000	0.982
Jiangsu	1.019	0.976	1.018	1.001	0.995
Zhejiang	1.032	0.954	1.000	1.032	0.985
Anhui	0.951	0.973	1.005	0.947	0.926
Fujian	1.057	0.956	1.007	1.050	1.010
Jiangxi	1.016	0.961	1.012	1.003	0.976
Shandong	1.040	0.957	1.006	1.034	0.995
Henan	1.027	0.981	1.034	0.994	1.008
Hubei	1.008	0.977	1.027	0.982	0.985
Hunan	1.003	0.971	0.998	1.005	0.974
Guangdong	1.018	0.954	1.000	1.018	0.971
Guangxi	1.011	0.961	1.005	1.006	0.972
Hainan	1.071	0.928	1.007	1.063	0.993
Chongqing	0.930	0.989	0.989	0.940	0.920
Sichuan	0.977	0.998	1.000	0.977	0.975
Guizhou	0.991	0.978	1.002	0.989	0.969
Yunnan	0.944	0.988	1.003	0.941	0.933
Tibet	1.000	0.908	1.000	1.000	0.908
Shaanxi	1.001	0.954	1.000	1.000	0.955
Gansu	0.948	0.984	0.998	0.950	0.933
Qinghai	1.018	0.953	1.000	1.018	0.971

Provinces	Effct	Techch	Pech	Sech	Tfpch
Ningxia	0.974	0.955	1.000	0.974	0.929
Xinjiang	0.939	0.973	1.000	0.939	0.914

Discussion

Along with the implementing of medical reform plan in 2009, great changed has made in medical service allocation, especially an outline of strategic program for development of TCM by the State Council in 2016. TCM has stepped into a fast-developing period. It has set several nationwide goals to access by the end of 2020. One of the tasks is to build a nationwide medical service network to ensure that all citizens can enjoy the basic services of TCM. As TCM achieved long-term development, there are still some equity and efficiency issues to be explored. We aimed to help Chinese government to optimize TCM resource allocation.

Currently, we used comprehensive economic methods to reveal the extent, nature and source of TCM health resource allocation among 2013 to 2017 in mainland China. We found that the overall numbers of TCM institutions, beds and health staffs and the numbers based on per 1000 persons and square meters grown steadily. It is indeed the results of our government increasing the health resource. The equity of health resource allocation was measured by the Gini and Theil index. Gini index was applied to judge the overall inequity, and Theil index was used to find the source of inequity. It showed that it had absolutely or relative equitable allocation of bed, health staffs and TCM institutions in terms of population. Gs in terms of population range from 0.10 to 0.29. The equity of TCM resource in terms of population is health staffs beds Institutions. However, the results of Gini coefficient based on geographical size were not ideal. Gs of geography areas range from 0.58 to 0.68. The scores were all above 0.5, which suggested a huge reginal disparities. The findings is consistence with the previous study[7]. The equity of TCM resource by geography size was Institutions beds health staffs. The results was in line with all health resource allocation[14, 19]. Similarity, more evidences indicated that the equity of health resource allocation in terms of population size was equitable than that in terms of geographic region[12, 14].

Theil analysis is a good way to find the sources of inequality, which is consisted of intra-groups and inter-groups inequality and the contribution rate within and between groups[20, 21]. After analysis, we found that the intra-group difference was the main reason resulting in the inequity in allocation or TCM health resources. The equity in three regions is health staffs beds Institutions, which is in line with the Gini coefficient by population. Moreover, the inequity by geographic region was western eastern middle. From the institution numbers in the western areas, we also found that in Sichuan had 50 times that of Tibet, and 8 out of 12 provinces in 2017 had the lower average institutions. This might explain the big gap in the western areas. In view of national conditions, the imbalance of economic development of western region resulting in the misdistribution of health allocation regardless of a decreasing contribution rate trend year by year. Surprisingly, the contribution rates of health resources in eastern and middle regions were growing in a steady small manner. The inequality gap among the western and middle areas was shrinking.

From the efficiency and productivity analysis, we found that all provinces in middle region had redundant inputs, which have not been entirely utilized. However, the inputs in western region with limit technical levels were better utilized than that in middle area. 4 out of 12 provinces in (Qinghai、Ningxia、Tibet and Xingjiang) in western region had no adjustment in the inputs. Moreover, we found that Beijing (eastern), Shanghai (eastern) and Tibet (western) should not adjust the inputs, outputs and scale under the present technical level. Zhejiang (eastern), Guangdong

(eastern) and Qinghai (western) should shrink scale, and Ningxia (western) and Xinjiang (western) need to adjust scale. The productivity had negative changes between 2014 and 2015, while the productivity in the other time periods had positive changes. We also found that the frequency distribution of Sech (score 1) increased since 2015. However, the frequency distribution of Techch (score 1) decreased year by year. As for Tfpch, it can be decomposed into Effct and Techch, while Effct can be divided into Pech and Sech, that is, Tfpch = Effct * Techch; Effct = Pech * Sech[17]. Technical improvement plays pivotal roles in the short-term development of medical service resource[22]. So we should improve technological levels and optimize scale continuously to obtain the long-term development.

There are some limits in our study. Firstly, in view of medical environment in China, many other indicators such as the workload of health staffs, turnover rate of beds and hospital expenses were not included in our analysis. Our findings might not reflect the whole status of TCM resources in China. Secondly, the health resource density index by population size or geographic area was not measured, which might cause some bias to our results. Thirdly, the efficiency and productivity values were not adjusted because of the limit of DEA method[23]. Fourthly, because the TCM data after 2017 was not available in China Health Statistical Yearbook. So we choose the recent 5 years periods to analyze. In the future, more indicators, longer time periods and better analysis approaches will be employed.

Conclusion

In our study, we comprehensively evaluated the equity and efficiency of TCM resource trend over 5 years. We found that TCM resource became more and more equitable in recent years. The equity in terms of population size got better than that by geography. The middle area was more equitable than the western area, which was consistent with the results of DEA analysis. The productivity in most provinces was negative changes. Middle region with larger scales had redundant inputs. However, western region with lower scale size had few redundancies. Although the increasing inputs shorten the reginal gaps and improve the equity, slow technology development were still barriers of the productive progress. Herein, with the exiting resource being allocated rationally and used effectively, technological progress and scale levels should be improved.

Declarations

Authors' contributions

ZJL conceived and designed the study. LLY collected the data. YYB provided several suggestions for manuscript revision.

Funding

This work was supported by the National Natural Science Foundation of China (No. 81603529, 81704084), the Natural Science Foundation of the Jiangsu Higher Education Institutions (No. 16KJB360002), the advantages of nursing discipline project of Jiangsu province (No. 2019YSHL005), the Jiangsu Government Scholarship for Overseas Studies, China Scholarship Council and Qing Lan Project.

Availability of data and materials

Please contact corresponding author for data requests.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors have no conflicts of interest to disclose.

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Figures

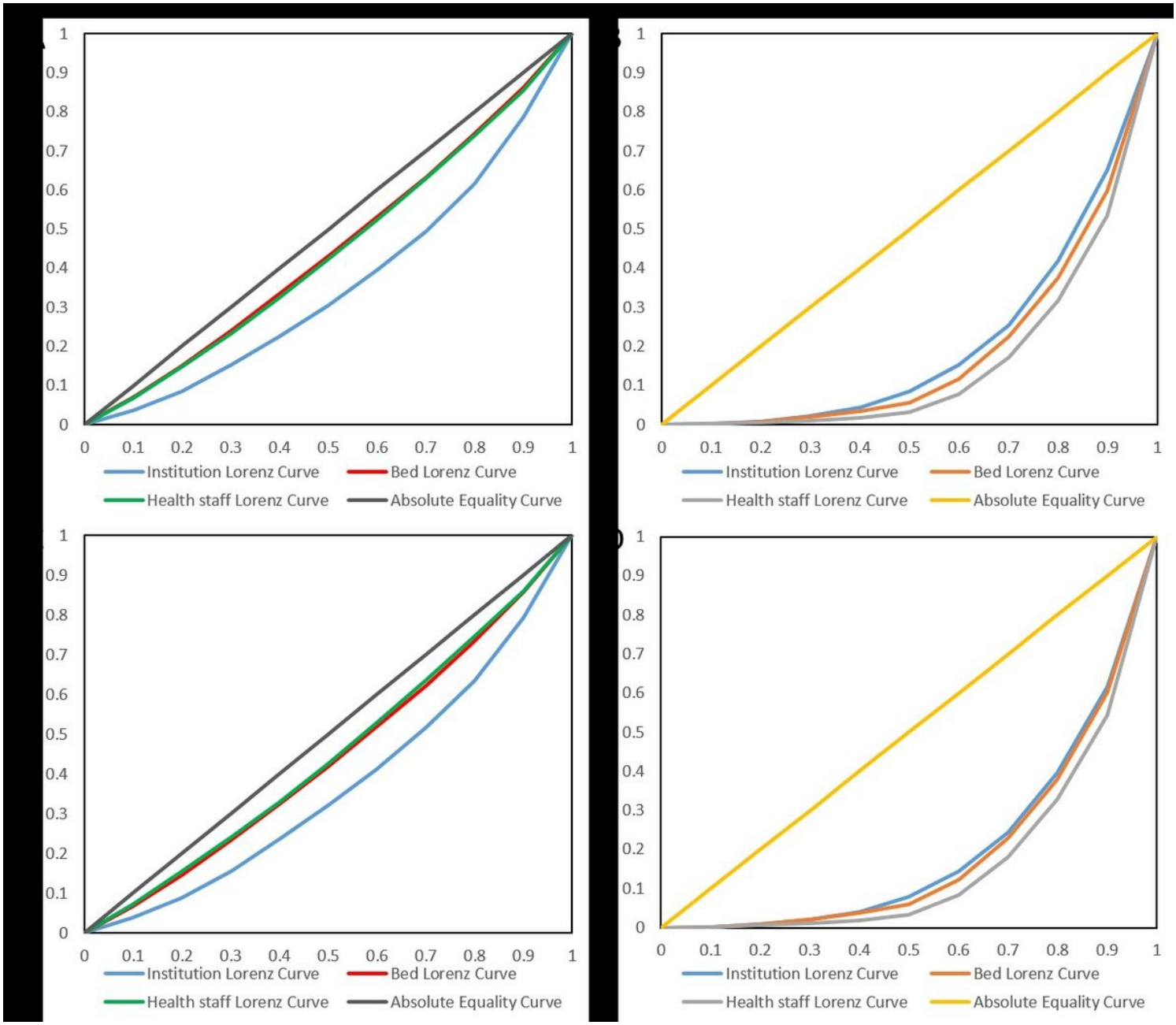

Figure 1

The Lorenz curves of health resources in 2013 (A and B) and 2017 (C and D). A and C as the Lorenz curves allocated by population; while B and C as the Lorenz curves allocated by geographical region.