

Analysis of the Equity of Health Human Resources in Chongqing Based on Agglomeration Degree

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Abstract

Objective: To provide reference for rational allocation of health human resources by exploring the current situation and equity of health human resources allocation in Chongqing. **Methods:** The data of health human resources in Chongqing from 2014 to 2018 were collected, and its equity was assessed by analyzing the agglomeration degree based on population and area size. **Results:** The number of health technicians, doctors and nurses per 1000 residents in Chongqing was 6.22, 2.22 and 2.76. The health human resources were redundant in Yuzhong, Jiangbei, and Dadukou Districts, but were seriously inadequate in Chengkou, Wuxi and Youyang counties. From 2014 to 2018, the equity of health human resources in main urban areas and the southwest of Chongqing were improved, but its allocation in the west and northeast of Chongqing was relatively inadequate, which became increasingly worse. **Conclusion:** The total amount of health human resources in Chongqing is insufficient. The differences in the equity of health human resources in different regions are significant. The equity of health human resources varies in different regions.

Keywords

Health Human Resources, Resources Allocation, Equity, Agglomeration Degree

1. Introduction

Human resources for health is defined as the sum and quality of health workers with certain professional skills in health industry during a certain time in a certain region, it is the key to maintaining and strengthening the function of health

systems and is an important indicator to measure the level of health services (Chen Xiao-ming, 2012). Health human resources is a main carrier of medical and health services, therefore, its reasonable allocation is essential to ensure residents' fair benefits and rights for health care and to promote equity in health-care industry (Xu Min-xuan & Jia Li-ying, 2018). Chongqing is the only municipality under the direct leadership of central government in western China, an important strategic fulcrum of the Silk Road and the main force for the construction of the Southwest, so analysis on the current situation of health human resources and the equity here has great significance. The approaches used in the previous studies of the equity of health human resources so far mostly concentrate on Gini coefficient, Lorenz curve, etc., which are single-dimension indexes with uncertainty and incompleteness (Liu Xiao-li, Xu Xiao-lan, & Zhou Le-ming, 2017). Therefore, under the condition of Chongqing health human resources allocation, this research comprehensively analyzed fairness with the use of the agglomeration degree of health human resources based on population and area size, compared the differences of health human resources between different regions, and put forward suggestions based on existing issues in order to provide reference for the development of scientific health strategies.

2. Data and Methods

2.1. Data

The data about health technicians were come from the official website of Chongqing Municipal Commission of Health, The data about practicing physicians and registered nurses were collected from the statistical yearbook. The data about population and area size were compiled from the Chongqing Statistical Yearbook.

2.2. Methods

Population agglomeration degree (PAD) is defined as the proportion of the population (%) in an area that accounts for 1% of the total area size, which reflects the degree of population agglomeration relative to the total population (Yuan Su-wei, Wei Feng-qing, & Liu Wen-wei, 2015).

$$\text{Calculation Formula: } PAD_i = \frac{\left(\frac{P_i}{P_n}\right) * 100\%}{\left(\frac{A_i}{A_n}\right) * 100\%}$$

P_i denotes the population of a certain area; A_i denotes a certain area size; P_n denotes the total population; A_n denotes the total area size.

Health human resources agglomeration degree (HRAD) is defined as the proportion of human health resources in a region that accounts for 1% of the total area size (%), which reflects the concentration of health human resources in a region relative to the total health human resources (Wang Wei, Li Yuan-ju, & Ma Lu-ye, 2017).

$$\text{Calculation Formula: } \text{HRAD}_i = \frac{\left(\frac{\text{HR}_i}{\text{HR}_n}\right) * 100\%}{\left(\frac{\text{A}_i}{\text{A}_n}\right) * 100\%}$$

HR_i indicates the amount of human health resources in a certain area, A_i indicates a certain area size, HR_n indicates the total health human resources, and A_n indicates the total area size.

When using the agglomeration degree to evaluate the allocation of health human resources, it is generally believed that the more the HRAD approaches 1, the fairer the allocation of health human resources by area size is, and the HRAD above 1 indicates the region's health human resources is redundant (Cheng Li-hui, Bai Ya-mei, & Song Yu-lei, 2018). When the HRAD/PAD = 1, that is, the ratio of the proportion of health human resources in an area that accounts for 1% of the total area size to the proportion of the population in the same area is equal to, meaning the allocation of health human resources by population is in a state of absolute equity; when HRAD/PAD > 1, indicating the health human resources are redundant for the population in that area; when HRAD/PAD < 1, indicating the health human resources are insufficient in that area (Hu Hui-mei, Chen Ding-wan, & Gao Qi-sheng, 2016).

3. Results

3.1. Status of Health Human Resources Allocation in Chongqing

Chongqing covers an area of 82,400 square kilometers and has 38 administrative districts. It is divided into four parts: main urban area, the west, the northeast, and the southeast (Figure 1). The main urban area includes Yuzhong, Dadukou, Jiangbei, Shapingba, Jiulongpo, Nan'an, Beibei, Yubei, Banan Districts; the west includes Fuling, Changshou, Jiangjin, Hechuan, Yongchuan, Nanchuan, Yongjiang, Dazu, Laoshan, Tongliang, Tongnan, and Rongchang Districts; the northeast of Chongqing includes Wanzhou, Kaizhou, Liangping, Chengkou, Fengdu, Dianjiang, Zhongshan, Yunyang, Fengjie, Wushan, and Wuxi Districts; the southeast includes Qianjiang, Wulong, Shizhu, Xiushan, Youyang, and Pengshui Districts (Chongqing Statistics Bureau, 2018).

By the end of 2018, there were 200,396 health technicians, 78,361 practicing physicians, and 95,104 registered nurses in Chongqing, accounting for 2.13%, 2.02%, and 2.23% nationwide, respectively, and the doctor to nurse ratio was 1:1.22. There were 6.22 health technicians, 2.22 practicing physicians, 2.76 registered nurses per 1000 residents; 2.35 health technicians, 0.83 practicing physicians, 1.03 registered nurses per square kilometer. From 2014 to 2018, the total health human resources in Chongqing showed an increasing trend. The number of registered nurses increased most significantly, with an average annual growth rate of 11.95%. The growth rates of health technicians and practicing physicians were 6.84 %, 7.74%, respectively, which are relatively small (Table 1).



Figure 1. The map of Chongqing area distribution.

Table 1. Chongqing human resources for health 2014-2018.

	Health technicians	Practicing physician	Registered nurse
2014	157,358	59,838	64,330
2015	166,812	61,013	69,996
2016	179,346	64,700	77,463
2017	191,254	68,419	84,768
2018	200,396	78,361	95,104

3.2. Results of Health Human Resources in Different Districts of Chongqing in 2018

3.2.1. Analysis of the Agglomeration of Health Human Resources Based on Area Size

According to **Table 2**, it could be seen that the HRAD values of Yuzhong, Dadukou, Jiangbei, Shapingba, Jiulongpo, Nan’an, Beibei, Yubei, Banan, Changshou, Hechuan, Hechuan, Yongchuan, Laoshan, Tongliang, Rongchang and Wanzhou Districts were greater than 1, indicating that the health human resources in these districts were redundant. The HRAD values of Jiangjin, Nanchuan, Dazu, Taonan, Kaizhou, Chengkou, Fengdu, Zhong, Yunyang, Fengjie, Wuxi, Qianjiang, Wulong, Shizhu, Xiushan, Youyang and Pengshui Districts were all smaller than 1, showing that the health human resources in those areas were relatively insufficient in terms of their area size.

3.2.2. Analysis of the Agglomeration of Health Human Resources Based on Local Population

There were significant differences in the results of HRAD/PAD in different districts of Chongqing. In terms of the allocation of health technicians, the HRAD/PAD

values of Yuzhong, Dadukou, Jiangbei, Shapingba and Jiulongpo Districts were much higher than 1, indicating that the health technicians in these areas was relatively redundant for local population, while the health human resources in Chengkou, Youyang, Wulong and Pengshui Districts were relatively inadequate. In terms of the allocation of practicing physicians, the HRAD/PAD values of Beibei and Bishan Districts were 1.007 and 0.991, which were the closest to 1, indicating that the allocations of practicing physicians in both districts were most equitable for local population. In terms of the allocation of registered nurses, the HRAD/PAD value of Yuzhong District was the highest, showing that the allocation of registered nurses was extremely redundant for the local population. The HRAD/PAD value of Wuxi District was the lowest, meaning that the allocation of registered nurses in this area was seriously insufficient (**Table 2**).

Table 2. Evaluation results of health human resources in 2018.

Administrative areas	PAD	Health technicians		Practicing physician		Registered nurse	
		HRAD	HRAD/PAD	HRAD	HRAD/PAD	HRAD	HRAD/PAD
Main urban area							
Yuzhong	74.472	343.483	4.612	298.153	4.004	391.94	5.263
Dadukou	9.251	11.582	1.252	12.884	1.393	11.865	1.283
Jiangbei	10.999	18.452	1.678	18.845	1.713	20.13	1.83
Shapingba	7.783	10.181	1.308	10.441	1.342	10.864	1.396
Jiulongpo	7.539	10.652	1.413	11.085	1.47	11.176	1.482
Nan'an	9.074	9.84	1.084	10.089	1.112	10.574	1.165
Beibei	2.863	2.917	1.019	2.882	1.007	2.821	0.986
Yubei	3.012	2.95	0.979	3.074	1.02	3.165	1.051
Ban'an	1.559	1.468	0.942	1.508	0.967	1.58	1.019
West							
Fuling	1.057	0.961	0.91	1.031	0.975	0.944	0.893
Changshou	1.576	1.219	0.773	1.214	0.77	1.237	0.784
Jiangjin	1.15	0.724	0.629	0.838	0.728	0.63	0.548
Hechuan	1.581	1.108	0.701	1.141	0.722	1.067	0.675
Yongchuan	1.904	1.674	0.879	1.61	0.846	1.708	0.897
Nanchuan	0.599	0.571	0.953	0.544	0.908	0.626	1.045
Qijiang	1.071	0.967	0.903	0.776	0.724	1.022	0.954
Dazu	1.469	0.931	0.634	0.958	0.652	0.849	0.578
Bishan	2.167	2.826	1.304	2.148	0.991	1.94	0.895
Tongliang	1.447	1.278	0.883	1.35	0.933	1.232	0.851
Tongnan	1.211	0.791	0.653	0.743	0.613	0.707	0.584
Rongchang	1.763	1.544	0.876	1.575	0.893	1.495	0.848

Continued

Northeast							
Kaizhou	0.799	0.573	0.718	0.649	0.812	0.55	0.689
Liangping	0.925	0.777	0.84	0.78	0.843	0.744	0.804
Wanzhou	1.268	1.325	1.045	1.484	1.17	1.319	1.041
Chengkou	0.153	0.131	0.859	0.126	0.824	0.105	0.687
Fengdu	0.534	0.431	0.807	0.394	0.738	0.417	0.781
Dianjiang	1.219	1.084	0.889	1.139	0.935	0.977	0.802
Zhong	0.888	0.612	0.689	0.681	0.767	0.551	0.62
Yunyang	0.68	0.464	0.683	0.529	0.777	0.372	0.546
Fengjie	0.477	0.362	0.758	0.351	0.735	0.358	0.75
Wushan	0.406	0.307	0.755	0.315	0.776	0.267	0.659
Wuxi	0.256	0.169	0.658	0.178	0.695	0.114	0.446
Southeast							
Qianjiang	0.533	0.613	1.15	0.483	0.907	0.654	1.228
Wulong	0.321	0.218	0.681	0.252	0.784	0.173	0.539
Shizhu	0.337	0.353	1.046	0.363	1.078	0.364	1.079
Xiushan	0.523	0.453	0.866	0.381	0.728	0.469	0.897
Youyang	0.284	0.18	0.634	0.184	0.647	0.16	0.561
Pengshui	0.337	0.243	0.721	0.239	0.708	0.225	0.669

3.3. Analysis of the Agglomeration Degree of Health Human Resources in Chongqing from 2014 to 2018

3.3.1. Trend of the Agglomeration Degree of Health Human Resources in Different Districts Based on Area Size

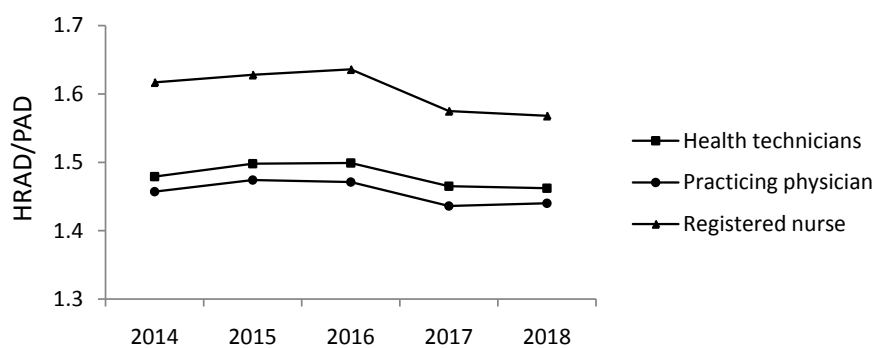
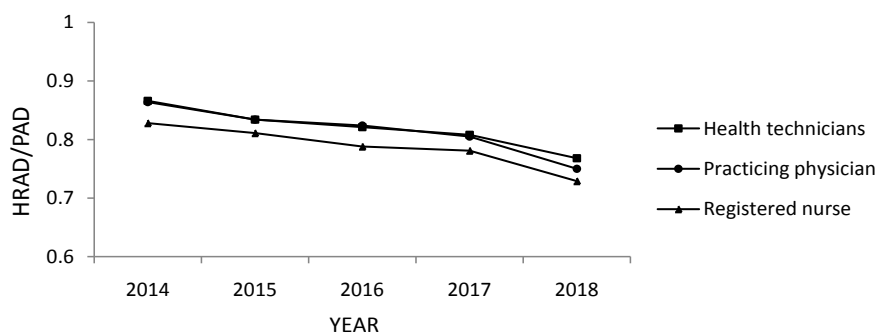
From 2014 to 2018, the HRAD values of health technicians and practicing physicians in the main urban area were greater than 1, while the values in the northeast and southeast of Chongqing were far less than 1, with a downward trend in fluctuation; the value of the western area was around 1, meaning the allocation of health human resources in the west were the most equitable. The values for registered nurses in main urban area have been rising year by year, but declined slightly in 2016; the values of registered nurses in Northeast and Southeast of Chongqing decreased in 2018, in comparison with those in 2013, meaning the equity of the allocation of registered nurses needs to be improved in terms of the area size (see **Table 3** for details).

3.3.2. Trend of the Agglomeration Degree of Health Human Resources in Different Regions Based on Population

As shown in **Figures 2-5**, the values of HRAD/PAD of the three indicators in the main urban area from 2014 to 2018 were much greater than 1, representing that the health human resources for the population in the area was redundant, but a slight downward trend was observed since 2015, meaning the situation is being improved. The values of HRAD/PAD of the three indicators in the west and

Table 3. Agglomeration of health human resources of the four major districts in Chongqing.

Area	Year	2014	2015	2016	2017	2018
PAD	Main urban area	3.96	4.011	4.089	4.21	4.237
	West	1.227	1.246	1.265	1.294	1.394
	Northeast	0.628	0.625	0.622	0.648	0.644
	Southeast	0.412	0.409	0.405	0.372	0.368
Health technicians						
HRAD	Main urban area	5.856	6.007	6.128	6.166	6.153
	West	1.176	1.039	1.039	1.045	1.07
	Northeast	0.628	0.553	0.532	0.539	0.524
	Southeast	0.362	0.337	0.339	0.311	0.31
Practicing physicians						
HRAD	Main urban area	5.768	5.913	6.014	6.046	6.103
	West	1.06	1.039	1.042	1.042	1.045
	Northeast	0.597	0.585	0.563	0.571	0.56
	Southeast	0.304	0.309	0.315	0.292	0.292
Registered nurse						
HRAD	Main urban area	6.402	6.529	6.688	6.632	6.641
	West	1.015	1.011	0.997	1.01	1.016
	Northeast	0.515	0.49	0.47	0.489	0.486
	Southeast	0.321	0.332	0.34	0.309	0.304

**Figure 2.** Ratio of health human resources agglomeration to population agglomeration in the main urban area.**Figure 3.** Ratio of health human resources agglomeration to population agglomeration in the east.

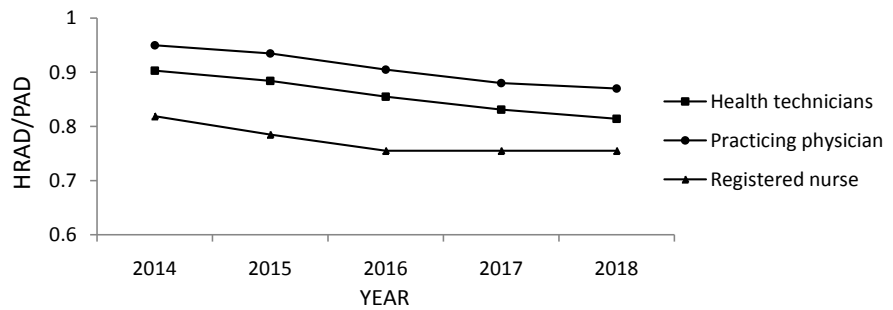


Figure 4. Ratio of health human resources agglomeration to population agglomeration in the northeast.

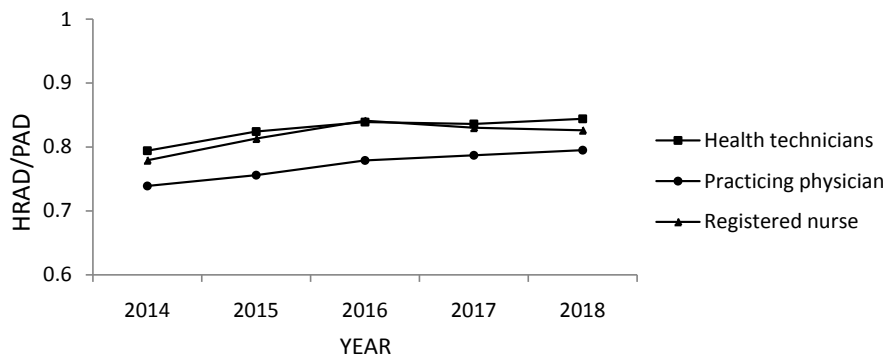


Figure 5. Ratio of health human resources agglomeration to population agglomeration in the southeast.

northeast of Chongqing were smaller than 1, and they have been continued to decline in the past five years, showing the allocation of health human resources for the population in these areas are poor, with serious shortage in health human resources. Although the value of the three indicators was smaller than 1, it kept growing in the past five years, meaning the equity of health human resources allocation has been gradually optimized.

4. Discussion and Suggestions

4.1. The Human Resources for Health Has Increased, but the Total Resources Are Still Insufficient

With the development of the economy, Chongqing's medical system has been continuously improved, and health resources in all aspects have also increased to a certain extent. However, the allocation of health human resources is still insufficient and the resources per capita are relatively scanty. The number of health technicians, practicing physicians, and registered nurses per thousand people in Chongqing are lower than the national average, much lower than in Beijing, Tianjin, and Shanghai. As mentioned in *Planning of Medical and Health System in Chongqing (2015-2020)*, the number of practicing physicians is 2.57 per 1000 people, and the number of registered nurses is 3.21 per 1000 people in Chongqing by 2020, which shows a certain gap in the allocation of health human resources, a gap that is prominent particularly in the Northeast and Southeast of

Chongqing. To solve these problems, on the one hand, policies for medical education must be made to ensure the quality and quantity of medical workers, given that medical education is the major source for cultivating medical workers. It is recommended that government formulate long-term training plans for health personnel and policies such as setting up scholarships and designing free and orientated training plans so as to attract more students into medical industry, involving outstanding students from the very beginning; On the other hand, it is recommended that the medical department improve the salary and working environment for medical workers so as to reduce staff turnover. These measures can continuously expand the medical group by increasing staff retention and decreasing staff turnover.

4.2. Significant Differences Existed in the Equity of Health Human Resources in Different Areas

The health human resources are seriously insufficient in underdeveloped areas including Wuxi, Youyang and Wulong Districts, due to lagged economic development and inadequate investment from governments. However, Yuzhong district, which takes up only 0.29% of the Chongqing's total area and 2.14% of the total population, is equipped with health human resources accounting for 9.89% of the total districts. This shows that Chongqing's human resources for health are excessively concentrated in the developed central areas, but are insufficient in remote and underdeveloped areas, with problems such as waste of resources and inadequacy. This result is basically consistent with the research conclusions of (Fu Xian-zhi, Lu Feng, & Cao Yun-yuan, 2017) and (Liu Li, 2012). Differences among regions are the main reason that causes inequity of health human resources. Therefore, authorities in the underdeveloped regions should make policies to attract more medical workers as they develop the economy, and the governments in urban central districts should strengthen cooperation and coordination with the underdeveloped regions, and assist in improving the status of health human resources in these areas with the use of their own resources. In addition, according to an relative study by (Zhou Di & Yuan Jie-song, 2018), the current health human resources are still not equitable enough, thus government at all levels should adjust and optimize the structure of health human resources allocation and improve the policies in fairness and guidance, so as to realize equitable and reasonable allocation of health human resources and narrow the gap between districts and regions.

4.3. The Equity of Health Human Resources Varies in Different Areas

According to the analysis of HRAD/PAD from 2014 to 2018, different development trends are shown in different regions. The redundant allocations of health human resources in main urban areas have gradually improved, as well as the equity of allocation in the southeast of Chongqing. However, the equity in the west and northeast has declined year by year. To conclude, the general equity of

health human resources in Chongqing has not been effectively improved. In order to meet needs of residents in different regions for health human resources, a system based on local conditions for the development of health human resources should be built in some regions, standards of the allocation should be made, and a layout for the composition and the number of medical workers should be determined. If the region has a large population, then this factor should be considered in the allocation of health human resources. If the region has a relatively small population, the needs and geographical factors should be paid attention to, so as to ensure the equity and accessibility of the allocation plan of health human resources.

In all, there is insufficient total health resource allocation in Chongqing, there are significant differences in the equity of health human resources in various regions, and the equity of health human resources in different regions is developing differently. It is suggested to increase the training of medical students in schools, cooperation in hospitals, and government planning to optimize the allocation of human resources in Chongqing.

There are still some limitations in this article. In terms of data, only the Chongqing region resources were analyzed vertically from 2014 to 2017, it was not compared with the data of other provinces in China or even other countries around the world. In terms of methods, this article only uses one method to evaluate fairness, depend on the existing essay, there are other methods that focusing on how to make better analyses. In future research, we will try our best to improve the above problems.

Conflicts of Interest

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

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