Postprint: Spatiotemporal Differentiation of Health Resources and Its Influencing Factors in Underdeveloped Areas Based on Geographical Detector

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Date: 2021-04-14T00:00:00+00:00

Abstract

Healthcare resources are the foundation and guarantee of the health service system, and high-level, highly equitable healthcare resources are the safeguard of people' s health. Taking Gansu Province as an example, this study analyzes the differences in the level and equity of healthcare resources across 14 cities and prefectures in Gansu Province from 2010 to 2017 based on health resource agglomeration degree, coefficient of variation, Gini coefficient, Theil index and its decomposition, and employs the Geographical Detector Model to analyze influencing factors. The results show that: (1) From 2010 to 2017, the level and equity of healthcare resources in Gansu Province increased overall. (2) The distribution of healthcare resource level and equity exhibits a southeast > northwest pattern, with economically better-off Longzhong and Longdong regions outperforming other areas, among which Lanzhou City has the highest resource level and equity. (3) The per capita level and equity of healthcare resources in Gansu Province are superior to those per unit land area; due to its vast area and relatively low population agglomeration degree, the per capita equity in the Hexi region is significantly better than its land area-based equity. (4) The overall disparity in healthcare resource levels in Gansu Province has gradually decreased, and the equity of healthcare resources has been notably improved; meanwhile, intra-regional differences have diminished while inter-regional differences have gradually increased, with internal differences in the Hexi and Longzhong regions being the main contributors to the overall disparity in Gansu Province. (5) Economic level is the dominant factor influencing healthcare resource levels, the interaction between per capita GDP and population aging with other factors shows high explanatory power, while the explanatory power of natural factors has increased year by year.

Full Text

Spatial-temporal Differentiation and Influencing Factors of Health Resources in Underdeveloped Areas Based on Geodetectors

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Abstract

Medical and health resources constitute the foundation and guarantee of a health service system, and high-level, highly equitable medical resources are essential for public health. Taking Gansu Province as an example, this study analyzes differences in the level and equity of medical and health resources across 14 prefecture-level cities and autonomous prefectures using health resource agglomeration degree, coefficient of variation, Gini coefficient, Theil index and its decomposition. The geographical detector model is employed to analyze influencing factors. Results show that: (1) From 2010 to 2017, the overall level and equity of medical and health resources in Gansu Province increased, with the level rising by 14.96%. (2) The distribution of resource level and equity exhibits a southeast-to-northwest pattern, with economically developed Longzhong and Longdong regions outperforming other areas. Lanzhou City demonstrates the highest resource level and equity. (3) Per capita medical and health resource levels and equity in Gansu are superior to area-based metrics. Due to its vast territory and relatively low population density, the Hexi region shows significantly better per capita equity than area-based equity. (4) Overall disparities in medical and health resource levels across Gansu are gradually decreasing, with equity showing marked improvement. Meanwhile, intra-regional differences are diminishing while inter-regional differences are increasing. Internal differences within the Hexi and Longzhong regions constitute the main contributors to overall provincial disparities. (5) Economic level represents the dominant factor affecting medical resource levels. The interaction between per capita GDP and population aging with other factors shows strong explanatory power, while the influence of natural factors is increasing annually.

Keywords: medical and health resource level; equity; regional differences; geographical detector

Introduction

The "Healthy China 2030" Planning Outline emphasizes that "health is an essential requirement for promoting people' s comprehensive development and a fundamental condition for economic and social development," and proposes requirements for optimizing the health service system and establishing a sound medical service system. Medical and health resources are crucial manifesta-

tions of the health service system. Adequate and equitable medical resources safeguard public health and represent an inherent requirement for building a harmonious society. Meanwhile, high-level, high-equity medical resources can improve admission and cure rates, thereby reducing infection and mortality rates. Since the new medical reform policy was introduced, China's medical and health standards have gradually improved. By 2017, the number of hospitals increased from fewer than 20,000 to 31,000, and the number of health technicians rose from 7.8 million to 12 million. However, in recent years, rapid urbanization has substantially increased public demand for medical and health resources, exacerbating the mismatch between population and existing resources.

China' s uneven economic development and significant regional environmental differences have led to the concentration of medical and health resources in large cities and central urban areas, creating a dual "siphoning effect" on health resources and patients. This has resulted in a severe "inverted triangle" pattern in medical resource allocation, constraining coordinated regional development and social equity. To address regional imbalances in medical and health resources, the Ministry of Health, Ministry of Finance, and National Population and Family Planning Commission jointly issued the "Opinions on Promoting the Gradual Equalization of Basic Public Health Services" in 2009, which called for narrowing inter-regional gaps in medical and health resources. The "Healthy China 2030" Planning Outline further emphasizes improving the fairness of health resource allocation. Against this background, studying the spatial-temporal differentiation of medical and health resources and analyzing their influencing factors is of great significance for regional medical resource planning and implementing the Healthy China strategy.

Gansu Province, located in northwestern China' s inland region and a key implementation area of the Belt and Road Initiative, remains a typical economically underdeveloped area due to historical and natural constraints. During the 12th Five-Year Plan period, although medical and health resource coverage in Gansu increased substantially, low levels and poor equity persist. Analyzing the spatial-temporal trends of medical resource levels in Gansu from 2010 to 2017 and clarifying regional differences can provide references for formulating reasonable medical and health policies in underdeveloped regions and facilitate rational resource allocation during public health emergencies to meet public medical needs.

International research on regional allocation of medical and health resources began earlier and has formed a relatively systematic and mature framework. Scholars consider whether medical resource allocation is equitable as an important criterion for measuring national medical security levels. Against this background, studies have examined spatial allocation of medical resources at different levels, analyzed the current situation and contradictions between different medical needs and resource allocation, focused on the equity of medical human resource allocation, and explored the influence of economic levels and population characteristics on medical resource equity. Domestic research on

medical and health resources is relatively macroscopic, typically analyzing equity, fairness, and accessibility from provincial scales or urban-rural comparison perspectives, with some scholars also examining medical human resource levels. Research areas have concentrated on national or central and eastern regions, with limited or outdated studies on western regions, relatively single evaluation indicators, and insufficient exploration of reasons for equity differences.

Given these gaps, this study takes Gansu Province as the research object, using data from 2010 to 2017 at provincial and prefecture levels. Based on the guiding indicators of the "National Medical and Health Service System Planning Outline (2015-2020)" and existing research, an indicator system is established to explore the level and equity of medical and health resources in Gansu and its 14 prefecture-level cities and autonomous prefectures, analyze their differences, and use geographical detectors to identify main factors influencing these differences. This provides references for formulating medical and health policies tailored to underdeveloped regions.

1. Materials and Methods

1.1 Data Sources

Medical and health resource indicators were selected based on principles of availability and irreplaceability. According to the "National Medical and Health Service System Planning Outline (2015-2020)" and the current status of community health services and hospital health service systems in China, and referencing existing domestic and international research, the number of medical and health institutions, hospital beds, public health technicians, practicing (assistant) physicians, registered nurses, and the number of equipment units valued above 10,000 yuan were selected to measure medical and health resource levels. Data for 2010-2017 were obtained from the Gansu Provincial Health Statistics Yearbook, Gansu Provincial Health and Family Planning Statistical Materials, and the Gansu Provincial Health and Family Planning Development Statistical Bulletin.

1.2 Research Methods

1.2.1 Health Resource Agglomeration Degree Health Resource Agglomeration Degree (HRAD) is used to evaluate the equity of medical and health resources. The "National Medical and Health Service System Planning Outline (2015-2020)" states that medical and health resource levels should consider both land area and population size. Therefore, this study uses HRAD to analyze the equity level of medical and health resources in Gansu Province. Population Agglomeration Degree (PAD) represents the proportion of the province' s population concentrated in a region' s land area, calculated as:

$$PAD = \frac{p_n}{P} \times 100\% \div \frac{A_n}{A} \times 100\%$$

where PAD is population agglomeration degree, p_n is the population of the nth prefecture, P is the total provincial population, A_n is the land area of the nth prefecture, and A is the total provincial land area.

HRAD measures the equity of medical and health resources from the perspective of provincial land area, representing the proportion of provincial medical and health resources concentrated in a region' s land area:

$$HRAD = \frac{y_n}{Y} \times 100\% \div \frac{A_n}{A} \times 100\%$$

where HRAD is health resource agglomeration degree, y_n is the medical and health resource level of the nth prefecture, and Y is the provincial medical and health resource level.

The equity of medical and health resources measured by population is defined as HRAD/PAD. The evaluation criteria for medical resource equity are: when HRAD = PAD = 1, the region' s medical resources are in absolute equilibrium; when HRAD/PAD > 1, the region has excess medical resources; when HRAD/PAD < 1, the region has insufficient medical resources and poor equity.

1.2.2 Regional Difference Measurement The coefficient of variation, Gini coefficient, and overall Theil index are used to measure overall changes in medical resource levels across 14 prefectures within the 2010-2017 range. The coefficient of variation describes the degree of difference in medical resource levels, with larger values indicating greater differences:

$$C_v = \frac{\sqrt{\frac{\sum_{n=1}^{N}(V_n - \bar{V})^2}{N}}}{\bar{V}}$$

where C_v is the coefficient of variation, N is the total number of prefectures in Gansu (14), V_n is the medical resource allocation level of the nth prefecture, and $\bar{V}$ is the average level across all prefectures.

The Gini coefficient measures the equity of medical resource levels:

$$G = \frac{1}{N}\left(N + 1 - 2\sum_{n=1}^{N}(N + 1 - n)V_n\right)$$

where G is the Gini coefficient and V_n is the cumulative proportion of medical resource levels from the 1st to the nth prefecture in ascending order.

The overall Theil index analyzes overall differences in medical resource levels in Gansu. Based on this, Gansu is divided into four regions: Hexi (Jiayuguan, Jinchang, Wuwei, Zhangye, Jiuquan), Longzhong (Lanzhou, Baiyin, Dingxi, Linxia), Longdong (Pingliang, Qingyang), and Longnan (Tianshui, Longnan,

Gannan). The Theil index decomposition is used to measure intra-regional and inter-regional differences:

$$T_{total} = T_{between} + T_{within} = \sum_{i=1}^{I} P_i \log \frac{P_i}{Y_i} + \sum_{i=1}^{I} P_i \sum_{j=1}^{J} p_{ij} \log \frac{p_{ij}}{y_{ij}}$$

where T_{total} is the overall Theil index, $T_{between}$ is inter-regional difference, T_{within} is intra-regional difference, I is the number of groups (4), P_i is the population of group i, Y_i is the total medical resource level of group i, p_{ij} is the population of city j in group i, y_{ij} is the medical resource level of city j in group i, and Y_I is the overall medical resource level of group i.

1.2.3 Geographical Detector Geographical detectors can be used to detect spatial stratified heterogeneity and reveal underlying driving factors. Factor detection and interaction detection in the geographical detector model are employed to identify key factors influencing differences in medical resource levels. Specific algorithms are detailed in reference [21].

2. Results Analysis

2.1 Overall Level of Medical Resources

From 2010 to 2017, the overall level of medical resources in Gansu Province showed an upward trend, increasing from 0.12 to 0.14 [Figure 1: see original paper]. The growth rates in the Hexi, Longzhong, Longdong, and Longnan regions were 24.60%, 11.51%, 14.91%, and 12.28%, respectively, reflecting continuous improvement in Gansu' s medical resource levels alongside social development.

2.2 Spatial-temporal Distribution of Medical Resource Level and Equity

Significant gaps exist in medical resource levels and equity among the 14 prefectures, with varying ratios of health resource agglomeration degree to population agglomeration degree. To visually represent spatial distribution characteristics, this study maps the spatial-temporal distribution of medical resource levels and compares it with equity distribution.

2.2.1 Spatial Distribution Characteristics of Medical Resource Level Medical resource levels in Gansu show substantial spatial differentiation, presenting a southeast-to-northwest pattern. Longzhong and Longdong regions have relatively high levels, while Hexi and Longnan regions have relatively low levels. At the prefecture level, Lanzhou has the highest level, followed by Tianshui, Pingliang, and Longnan, while Jiayuguan, Jinchang, and Gannan have lower levels. From 2010 to 2017, all prefectures except Jinchang (which slightly decreased) showed upward trends. Jiayuguan, Wuwei, and Dingxi experienced

growth rates of 50.79%, 31.96%, and 41.84%, respectively, with overall improvement in the Hexi region.

2.2.2 Spatial Distribution Characteristics of Medical Resource Equity

As shown in [Figure 2: see original paper], the spatial distribution of medical resource equity in Gansu also presents a southeast-to-northwest pattern, largely consistent with the distribution of resource levels. Longzhong and Longdong regions show higher overall equity, while Longnan and Hexi regions show relatively poor equity. Lanzhou has the highest level and equity. From 2010 to 2017, medical resource equity in 11 prefectures increased, with growth rates of 9.61% in Longdong, 23.39% in Longzhong, 21.72% in Hexi, and 9.30% in Longnan.

2.3 Evolution Trend of Medical Resource Level Differences

The coefficient of variation, Gini coefficient, and Theil index measure differences in medical resource levels, with Theil index decomposition analyzing intra-regional and inter-regional differences. The overall difference in medical resource levels in Gansu shows a general downward trend despite fluctuations [Figure 3: see original paper]. Specifically, the coefficient of variation decreased from 0.67 to 0.62 (a 7.46% decline), the Gini coefficient decreased from 0.35 to 0.31 (an 11.56% decline), and the Theil index decreased from 0.21 to 0.18 (a 14.29% decline). The decreasing fluctuation amplitude indicates that overall differences declined annually from 2010 to 2017, with improving overall equity and gradual stabilization. This demonstrates the effectiveness of new medical reform policies, which have improved the fairness of medical resource allocation in Gansu, with the overall imbalance showing a downward trend despite minor fluctuations in individual years.

Using the Theil index decomposition at three time nodes (2010, 2013, 2017) reveals that different factors caused disparities at different times . In 2010, intra-regional contributions exceeded 50%, indicating that overall differences were mainly caused by intra-regional disparities. In 2017, inter-regional contributions exceeded 50%, indicating that overall differences were mainly caused by inter-regional disparities among the four major regions. The contribution of intra-regional differences shows a general downward trend, with Hexi, Longzhong, and Longdong all showing declining trends, while Longnan shows a significant increase. The contribution of inter-regional differences fluctuated and declined from 2010 to 2013 but rose significantly from 2013 to 2017, indicating gradually increasing inter-regional differences, particularly between Hexi and Longdong regions. In summary, while the equity of medical resource levels in Gansu has improved overall, unreasonable layout structures have affected the balance and fairness of medical services, with particularly significant gaps between regions.

2.4 Analysis of Influencing Factors

Medical resource level differences are caused by multiple factors. Based on existing research [22-24] and the "National Medical and Health Service System

Planning Outline (2015-2020)" , influencing factors are categorized into socio-economic development level, population distribution, and topographic factors .

2.4.1 Factor Detection shows the explanatory power of various influencing factors on medical resource levels at the prefecture level in Gansu. Results indicate that economic and population factors are the dominant factors affecting medical resource distribution. Overall, both show strong explanatory power.

(1) Among economic factors, the proportion of non-agricultural industry shows the highest explanatory power, followed by per capita GDP. The explanatory power of medical expenditure proportion is increasing. Economic level determines medical resource levels and is a fundamental influencing factor. Economically developed areas like Lanzhou have higher population agglomeration and greater demand for medical resources. Investment in medical and health services determines local resource levels.

(2) Among population factors, urbanization rate shows higher explanatory power, while population aging shows decreasing influence. Population factors are decisive for medical resource levels and play a leading role in resource allocation decisions. Urbanization has the most prominent impact on medical resource levels in Gansu' s prefectures—higher urbanization rates create greater demand. Population aging increases medical, rehabilitation, and elderly care needs, but rising health awareness among the elderly has improved their overall health levels, slightly reducing demand for medical resources.

(3) Although topographic factors show relatively low overall explanatory power, their influence is strengthening and showing an upward trend. Terrain affects the accessibility of medical resources. Research by Liu Ze et al. [25] indicates that in remote mountainous areas with complex terrain, transportation limitations affect the availability of medical services. Gansu has complex topography—the Hexi region is relatively flat with better resource accessibility, while Longzhong and Longdong have numerous valleys, and Longnan has high altitude and rugged terrain with relatively poor resource accessibility. Additionally, terrain determines hospital site selection. With economic development and urbanization, the "climbing slope" phenomenon has emerged. When urban construction land is insufficient, whether medical resources also need to "climb slopes" will be a decisive factor.

2.4.2 Interaction Detection Interaction detection compares the q-values of individual factors with those of factor interactions to analyze interaction types between any two factors. Using 2017 as an example, interaction detection was performed based on factor detection results. The findings show that any combination of two factors interacts to affect medical resources, with interaction

explanatory power greater than that of single factors, primarily through bi-factor enhancement and secondarily through non-linear enhancement .

Before 2010, interactions were mainly bi-factor enhancement and non-linear enhancement, with the interaction between non-agricultural industry proportion and population aging showing the highest explanatory power. After 2013, non-linear enhancement weakened, gradually shifting to bi-factor enhancement, with interactions between population aging and per capita GDP and between population aging and urbanization rate showing the highest values, followed by the interaction between urbanization rate and slope. In 2017, bi-factor enhancement dominated, with interactions between population aging and per capita GDP and between population aging and urbanization rate showing higher values. By 2017, bi-factor enhancement remained dominant, though the explanatory power of interactions between population aging and other factors slightly decreased, while interactions between non-agricultural industry proportion and other factors significantly increased, with the interaction between per capita GDP and non-agricultural industry proportion showing the highest value. Overall, interactions between per capita GDP, population aging, and other factors show high explanatory power.

3. Discussion

From 2010 to 2017, medical resource levels in Gansu Province steadily improved while equity differences gradually declined, generally consistent with national medical service system development trends [26], indicating effective implementation of new medical reform policies since 2009 and laying the foundation for equalizing basic public services and improving the public service system.

The study found that economic development level is the dominant factor causing regional differences in medical resource levels, consistent with national research findings that economically developed regions have more balanced medical resources [27]. Therefore, governments at all levels should strengthen differentiated allocation policies, increase funding and subsidies for medical and health services in underdeveloped areas, improve local supply capacity, and promote balanced development. The study also found that topographic factors are not dominant in causing regional differences in Gansu' s medical resources, but their explanatory power is increasing annually. Related research shows that remote mountainous areas have low medical resource levels due to geographical and environmental constraints [28]. Therefore, it is necessary to optimize salary benefits and employment subsidies in remote mountainous areas, promote the introduction of medical talent, improve local public medical service experience, and alleviate the current imbalance in spatial distribution of medical resources.

This study has several limitations. Due to data availability constraints, the analysis is limited to the prefecture-level scale and does not analyze the status of individual medical resource indicators. Future research should consider more micro-level scales such as county-level medical resource levels and equity, and

strengthen analysis of individual medical resource indicators.

4. Conclusion

Medical and health resource levels guarantee public health, and an equitable, fair medical service system can not only better satisfy people' s pursuit of healthy lives but also promote harmonious social development. This study analyzes medical resource levels and regional differences in Gansu from 2010 to 2017 at both provincial and prefecture levels, and identifies influencing factors using geographical detectors. The main conclusions are:

(1) Medical resource levels in Gansu Province showed growth from 2010 to 2017, increasing from 0.12 to 0.14. The growth rates in Hexi, Longzhong, Longdong, and Longnan regions were 24.60%, 11.51%, 14.91%, and 12.28%, respectively, with Hexi showing the most significant growth.

(2) Both medical resource levels and equity in Gansu present a southeast-to-northwest pattern. Economically developed Longzhong and Longdong regions have relatively higher levels and equity than other areas, with Lanzhou, Pingliang, and Longnan showing relatively high overall equity.

(3) Per capita medical resource levels and equity in Gansu are superior to area-based metrics. The HRAD/PAD ratio in the Hexi region is significantly higher than 1 due to its vast territory and relatively low population density, resulting in better per capita equity than area-based equity.

(4) Overall differences in medical resource levels across Gansu gradually decreased from 2010 to 2017, indicating successful new medical reform policies and improved equity. Intra-regional differences are diminishing while inter-regional differences are increasing, with internal differences in Hexi and Longzhong regions being the main contributors to overall provincial disparities.

(5) The explanatory power of influencing factors varies by year. Per capita GDP, non-agricultural industry proportion, and urbanization rate strongly influence medical resource levels and are decisive factors. The interaction between population aging and per capita GDP with other factors shows the strongest explanatory power. Economic and population factors significantly impact medical resource levels, while terrain' s influence continues to increase.

References

[1] National Health Commission of the People' s Republic of China. Central Committee of the Communist Party of China and The State Council issued the Outline of the Healthy China 2030 Plan[EB/OL]. http://www.moh.gov.cn/zhuz/xwfb/201610/21d120c917284007ad9c7aa8e9634bb4.shtml, 2016-10-25.

[2] Gong Shengsheng, Chen Yun. Temporal spatial relationship between health resources and residents' health in southern China[J]. Geographical Research, 2020, 39(1): 115-128.

[3] Yang Xiaosheng, Liu Hailan. Health resource geographic allocation and health outcome: An empirical analysis based on cross province data[J]. Chinese Health Economics, 2016, 35(1): 63-65.

[4] Ren Yuan. Urban pathology and smart management of high density city[J]. Journal of Social Sciences, 2018(5): 76-82.

[5] Ma Zhifei, Yin Shanggang, Qiao Wenyi, et al. Spatial equilibrium state and its time evolution of medical health resource supply level in China[J]. Scientia Geographica Sinica, 2018, 38(6): 869-876.

[6] Tian Lingling, Zhang Jin, Wang Fahui, et al. Rural public medical resources allocation spatial optimization towards equity and efficiency access: A case study on Xiantao City, Hubei Province[J]. Scientia Geographica Sinica, 2019, 39(9): 1455-1463.

[7] Zheng Jicheng. Study on the equilibrium of health resource allocation in China[J]. Chinese Health Resources, 2019, 22(5): 362-366.

[8] Song Xueqian, Deng Wei, Zhou Peng, et al. Spatial equity and influences of two level public healthcare resources: A background to hierarchical diagnosis and treatment reform in China[J]. Acta Geographica Sinica, 2019, 74(6): 1178-1189.

[9] Sun Liang, Zhao Ting, Xu Maolin, et al. Equity analysis of implementation effect of national basic public health service projects in Zhengzhou, 2011—2016[J]. Chinese Journal of Public Health Management, 2019, 35(5): 581-584, 606.

[10] Cheng Min, Lian Yuejiao. Spatial accessibility of urban medical facilities based on improved potential model: A case study of Yangpu District in Shanghai[J]. Progress in Geography, 2018, 37(2): 266-275.

[11] Annette J Browne, Colleen Varcoe, Marilyn Ford Gilboe, et al. EQUIP Healthcare: An overview of a multi-component intervention to enhance equity oriented care in primary health care settings[J]. International Journal for Equity in Health, 2015, 14: 152.

[12] Evans Nicholas Greig, Sekkarie Mohamed A. Allocating scarce medical resources during armed conflict: Ethical issues[J]. Disaster and Military Medicine, 2017, 3(1): 2-6.

[13] Saeede Eftekhari, Niam Yaraghi, Ranjit Singh, et al. Do health information exchanges deter repetition of medical services?[J]. ACM Transactions on Management Information Systems, 2017, 8(1): 31-57.

[14] Saksonov Stanislav G, Gruzeva Tetiana S, Vitovska Oksana P. Health of ophthalmologists as a prerequisite of quality medical services[J]. Wiadomosci

Lekarskie, 2018, 71(1-2): 165-167.

[15] Seongkum Heo, Jean McSweeney, Pao Feng Tsai, et al. The associations of diagnoses of fatigue and depression with use of medical services in patients with heart failure[J]. The Journal of Cardiovascular Nursing, 2019, 34(4): 289-296.

[16] Giorgio Cometto, James Campbell. Human resources for health[J]. Lancet, 2016, 388(10063): 2993.

[17] Liu Ze, Yang Hongyu, Xiong Weikang, et al. Spatial accessibilities of medical services at county level based on optimized two step floating catchment area method[J]. Scientia Geographica Sinica, 2017, 37(5): 728-737.

[18] Li Jun, Dong Suocheng, Chen Yanxiao. Recognition of areas with poor county medical resource along Yellow River in Ningxia and Inner Mongolia by spatial access[J]. Journal of Arid Land Resources and Environment, 2018, 32(3): 39-43.

[19] Chen Yufan, Wang Kaiyong. Influence and mechanism of turning counties (cities) into districts on urban public service allocation and spatial layout[J]. Economic Geography, 2019, 39(5): 76-86.

[20] Jiang Yupei, Zhen Feng, Sun Honghu. Spatial characteristics of urban health resources at block scale: A case study of central urban area of Nanjing[J]. Economic Geography, 2018, 38(1): 85-94.

[21] Wang Jinfeng, Xu Chengdong. Principle and perspective of geographical detector[J]. Acta Geographica Sinica, 2017, 72(1): 116-134.

[22] Liu Qian, Li Chenggu, Shen Qingxi, et al. Spatial evolution character of medical facilities in Changchun City[J]. Economic Geography, 2017, 37(7): 139-145.

[23] Ding Tingting. Research on the allocation of human resources in primary medical care since the new medical reform: A case study of Jiangsu Province[J]. China Collective Economy, 2019(34): 108-109.

[24] Cui Tingting, Xiong Jixia. Analysis of the equity of health resources allocation of traditional Chinese medicine in China based on the agglomeration degree[J]. Chinese Hospital Management, 2017, 37(7): 18-20, 61.

[25] Liu Liang, Luo Da, Bi Changwei, et al. Study on the medical and health resource allocation of Tianjin based on gini coefficient and agglomeration degree[J]. Chinese Health Economics, 2019, 38(5): 48-50.

[26] Zhao Xueyan, Wang Xiaoqi, Liu Jianghua, et al. Regional differences of quality medical resources in China based on different scales[J]. Economic Geography, 2020, 40(7): 22-31.

[27] Zheng Wensheng, Jiang Huaxiong, Ai Hongru, et al. Analysis of regional inequalities of basic medical resources supply in China[J]. Geographical Research, 2015, 34(11): 2049-2060.

[28] Kang Jiayu, Suo Zhihui, Liang Liuke, et al. Temporal and spatial evolution and its affecting factors of housing affordability at urban scale in China[J]. Arid Land Geography, 2019, 42(5): 1153-1165.

[29] Ding Jinmei, Yang Kui, Ma Caihong, et al. Spatial temporal evolution of grain production in China[J]. Arid Land Geography, 2017, 40(6): 1290-1297.

[30] Li Xiaoyue, Li Tongsheng, Long Dongping, et al. Spatial temporal evolution and driving factors of rural resident' s net income in northwestern China: A case study of counties in Shaanxi Gansu Ningxia Region[J]. Arid Land Geography, 2014, 37(3): 620-629.

[31] Zhao Yu. Comprehensive evaluation of rural primary medical service level in China' s provinces and regions: Based on factor analysis method[J]. Public Finance Research, 2013(4): 28-33.

[32] Liang Weijia, Tang Yuanmao. Study of health resource spatial non-equilibrium allocation in China[J]. Health Economics Research, 2018(9): 66-71.

Note: Figure translations are in progress. See original paper for figures.