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Research on Optimum Aging of Medical Facilities in Resource-exhaustion-type Industrial Towns Based on Balance of Supply and Demand—Taking Jiawang District in Xuzhou as an Example

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ABSTRACT

This paper starts from contradictions between senior citizens' medical demands and provision of medical facilities and intends to study the optimum aging distribution of the current medical facilities space in resource-exhaustion-type industrial towns, which will be of important significance to the planning and construction of medical facilities during the development process of industrial towns. This paper takes Jiawang District in Xuzhou as research objects and starts from supply and requisitioning parties on the basis of minimum quantity demand of senior citizens' medical facilities in Jiawang District, intending to study the equity of maximum provision service scope and rationality of nearest hospital distance; thereby providing certain research basis and optimization basis for optimum aging configuration of medical facilities in industrial towns.

Aging of population has become a severe social problem faced by all countries in the world. "hospitals for senior citizens" is an important guarantee for the health of senior citizens. To reach these objectives, there must be rational space configuration of medical service facilities. Compared with ordinary towns, resource-exhaustion-type industrial towns are under huge influences of the growth, maturity and decline of resources. Compared with ordinary towns, industrial towns have different employment structure, transportation network and space distribution and their public service facility configuration methods are different from other towns. Resource-exhaustion-type industrial towns have high degree of aging, so they have urgent demands for better and fairer medical resource configuration.

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LITERATURE REVIEW

Researches on medical treatment and public health are concentrated on the evaluation of rationality and accessibility of spatial configuration of medical facilities as well as siting analysis of medical facilities. Among them, Utilization of Health Service Behavior Model proposed by Ronald Andersen（1995）and his academic team is the most influential[1]. In Moon and Chaudhry (1984) researches, facility locational model is divided into four types, which are minimization or maximization, minimization maximum value or minimization minimum value and multiple criteria[2]. Based on Accessibility Relevance Theory, Fu Jiasen & Wang Li (2015) et al took GIS network and spatial analysis technology as the basis and evaluated medical accessibility in Dalian[3]. Zheng Chaohong (2011) evaluated the rationality of medical institution spatial distribution on the basis of GIS technology and spatial accessibility index[5]; Peng Cheng & Chen Zhifen (2013) et al established evaluation index system from the perspectives of convenience of medical institutions for providing service and the convenience of communities for obtaining service[6].

ANALYSIS OF MEDICAL FACILITIES OPTIMUM AGING BALANCE OF SUPPLY AND DEMAND

Balance of supply and demand of medical facilities means on the basis of satisfying minimum total demand, equity of service coverage in supply and accessible rationality in demand can be obtained; finally, benefit maximization of resources is formed. Through basic statistics, medical facilities optimum aging minimum quantity demanded and current status supply and demand ratio can be calculated; then, maximum service scope is used to refer to the supply capacity of medical facilities, nearest hospital distance is used to refer to the degree of residents demands for medical resources; through GIS model and data calculation, equity and rationality of the two are calculated; finally, considering that the cost of medical facilities spatial configuration change is huge, minimum facilities points model is chosen to optimize medical facilities optimum aging spatial configuration. The following parts are the detailed analysis method.

Calculation of Minimum Quantity Demand of Medical Resources Optimum Aging

Senior citizens' annual hospitalization rate is the ratio of in-patient number to the overall number of population. On this basis, the calculation of senior citizens' minimum demand for medical hospital beds can reflect the minimum demand standard of senior citizens' demand for medical hospital beds. Likewise, senior citizens' two-week outpatient rate, physicians' daily treatment of senior citizens can be used to calculate senior citizens demand for physicians and their minimum demand standard for medical service physicians.

Analysis of the Rationality of Nearest Hospital Distance

Nearest Distance Model is applied for analysis of spatial distribution of medical facilities in Jiawang District; then, Nearest Hospital Distance Model is applied for analysis of the obtained data and calculation of variable coefficient so as to confirm

whether the fluctuation range is in reasonable scale. The nearer the nearest distance that residents have to go to the medical institutions, the better spatial accessibility of residents health service. If hospitals are distributed reasonably, the nearest distance residents to the medical institutions should be balanced; if hospitals distribution is optimized, the nearest distance should tend to be more balanced. The variable coefficient is calculated according to SD (Standard Deviation).

RESEARCH ON MEDICAL FACILITIES OPTIMUM AGING IN ALL TOWNS OF JIAWANG DISTRICT

Current Status of Supply and Demand of Medical Facilities Optimum Aging in All Towns

Jiawang District has 7 towns altogether, which are Jiawang Town, Qingshanquan Town, Zizhuang Town, Biantang Town, DaWu Town, JiangZhuang Town and Tashan Town. To study medical facilities optimum aging, firstly, one has to understand the current status of supply and demand.

Table 1. Comparison and Analysis of Medical Facilities Supply and Demand in Jiawang District.*

	Aging bed			aging physician		
	S	MD	SDR	S	MD	SDR
Jiawang	1186	518	2.29	480	205	2.34
Qingshanquan	90	220	0.41	49	87	0.56
Zizhuang	80	401	0.20	63	159	0.40
Biantang	123	280	0.44	62	111	0.56
Dawu	265	620	0.43	120	245	0.49
Jiangzhuang	81	201	0.40	49	79	0.62
Tashan	125	527	0.24	57	208	0.27
Total	1950	2766	0.70	880	1095	0.80

*S for Supply, MD for Minimum demand, SDR for Supply and demand ratio

From the quantitative analysis of the current status of medical facilities optimum aging, we can know that: firstly, the overall medical facilities optimum aging service standard in Jiawang District is quite backward; secondly, medical facilities optimum aging supply and demand in 7 towns of Jiawang District are polarized severely, and only the supply demand in Jiawang Town can satisfy senior citizens demands, and supply is far larger than demands; supply demand of medical facilities in other 6 towns are in severe shortage and cannot satisfy senior citizens minimum demands for medical facilities.

Research on Medical Facilities Service Scope Optimum Aging

Table 2. Counts of medical services in the towns and the number of elderly persons and the settlement in the service area.*

Town	S_1	S_2	P_1	P_2
Jiawang Town	76.09	37.97	79.91	78.95
Qingshanquan Town	41.05	63.49	48.55	38.46
Zizhuang Town	39.22	83.56	49.74	47.06
Biantang Town	32.22	100	55.68	52.94
Dawu Town	69.65	73.34	81.33	72.22
Jiangzhuang Town	14.84	86.73	24.37	27.27
Tashan Town	35.60	100	39.21	39.13
total	46.94	58.49	59.14	52.54

*S_1 for Service coverage ratio, S_2 for Services Utilization ratio, P_1 for Percentage of services for the elderly, P_2 for Percentage of services settlement.

According to the calculation formula of the above service scope, the medical facilities service scope coverage analysis in Table 2 is obtained. From the perspective of the overall service scope coverage housing estates in Jiawang District and the proportion of aged population, the spatial distribution of medical facilities service scope in Jiawang District is unreasonable, which results to the fact that it only covers 59.14% of senior citizens and 52.54% of housing estates and quite a part of senior citizens （40.86%）and housing estates （47.46%）are beyond the service scope. In conclusion, it indicates that the spatial distribution of the medical facilities in Jiawang District still has a lot of improvement space in optimum aging. Medical facilities in Jiawang District is unreasonable in spatial distribution, which makes the overall medical facilities in Jiawang District over-concentrated in Jiawang Town; it restricts the overall medical facilities use ratio in Jiawang District severely and reduces service efficiency greatly, thereby causing the giant gap of medical facilities optimum aging in Jiawang Town and other towns.

Research of Medical Facilities Spatial Accessibility Optimum Aging

Table 3. Distance from the settlement to the primary hospital*

	<3km				>3km			
	E	P_1	T	P_2	E	P_1	T	P_2
Jiawang Town	6223	42.36	8	42.11	8468	57.64	11	57.89
Qingshanquan Town	2596	41.71	4	30.77	3628	58.29	9	69.23
Zizhuang Town	4715	41.53	7	41.18	6639	58.47	10	58.82
Biantang Town	1623	20.44	3	17.65	6317	79.56	14	82.35
Dawu Town	11643	66.22	10	55.56	5940	33.78	8	44.44
Jiangzhuang Town	2292	40.27	4	36.36	3399	59.73	7	63.64
Tashan Town	5023	33.64	8	34.78	9925	66.48	15	65.22

*E for The elderly,T for The settlement

Table 4. Distance from the settlement to the district-level hospital

	<7.5km				>7.5km			
	E	P_1	T	P_2	E	P_1	T	P_2
Jiawang Town	9676	65.86	13	68.42	5015	34.14	6	31.58
Qingshanquan Town	1002	16.10	2	15.38	5222	83.90	11	84.62
Zizhuang Town	0	0	0	0	11354	100.00	17	100.00
Biantang Town	0	0	0	0	7940	100.00	17	100.00
Dawu Town	0	0	0	0	17583	100.00	18	100.00
Jiangzhuang Town	538	11.40	1	9.09	5153	90.55	10	90.91
Tashan Town	0	0	0	0	14930	100.00	23	100.00

According to the functional orientation and service scope of basic-level medical facilities and district-level medical facilities and senior citizens' going-out abilities, the distance from housing estates to the nearest basic-level and district-level medical facilities should not be larger than 3km and 7.5km. From table 3, it is clear that there are 44 housing estates whose distance to the nearest basic-level medical facilities is smaller than 3 km, taking up 37.29% of the total number. The number of senior citizens whose nearest hospital distance is smaller than 3 km is 34115, only taking up 43.51% of the total number of senior citizens in Jiawang District, smaller than half of the total number of senior citizens; as for average hospital distance to the nearest basic-level medical facilities, only Zizhuang Town and Dawu Town are smaller than 3 km and the distance of other 5 towns are all larger than 3 km; Biantang Town is the largest, which is 5.16 km. From table 4 the nearest distance from housing estates in Jiawang District to the two district-level medical facilities, it is clear that these two hospitals are all in the central urban area of Jiawang District, and there are only 200 meters between these two hospitals. Therefore, the nearest district-level medical facilities of only 11216(14.30%)senior citizens and 16(13.56%) housing estates in Jiawang District is smaller than 7.5km, and the nearest hospital distance of the rest 85.70% senior citizens is larger than 7.5km; among the 7 towns in Jiawang District, only the average distance of Jiawang Town is smaller than 7.5 km, and the average distance of the whole distance is 14.67km, far larger than the ideal hospital distance of 7.5 km.

Table 5. The S and V of distance from residential to medical facilities.

	the primary hospital			the district-level hospital		
	$\bar{x}$	S	V	$\bar{x}$	S	V
Jiawang Town	3.54	2.08	0.60	6.33	2.72	0.43
Qingshanquan Town	3.94	2.14	0.54	11.50	3.94	0.34
Zizhuang Town	2.77	1.42	0.81	13.62	3.20	0.23
Biantang Town	5.16	2.55	0.49	18.84	2.62	0.14
Dawu Town	2.75	1.26	0.46	13.60	2.44	0.18
Jiangzhuang Town	33.40	1.92	0.56	9.30	3.68	0.39
Tashan Town	3.88	1.92	0.50	24.46	3.37	0.14
Total	33.63	2.08	0.57	14.67	3.14	0.36

Calculation of variable coefficient is conducted according to the nearest hospital distance analysis formula in Jiawang District. table 5is the variable coefficient from housing estates in Jiawang District to the nearest medical facilities hospital distance. The variable coefficients in Jiawang District is 0.57 and Jiawang District from all towns to the nearest basic-level medical facilities hospital distance are all 0.46-0.60, and they have all exceed the rational value of 15%, which indicates that the hospital distance of all housing estates in Jiawang District

fluctuates greatly. Combining previous analysis, the fundamental reason is the unreasonable spatial distribution of basic-level medical facilities. As for the hospital distance from housing estates in Jiawang District to the nearest district-level medical facilities, Jiawang Town has the largest variable coefficient. Though the two district-level medical facilities are between Jiawang Town, the distance between the two hospitals is only over 200 meters. This unreasonable spatial distribution causes the great fluctuation from housing estates in Jiawang Town to the two district-level medical facilities hospital distance.

ANALYSIS ON THE CAUSE OF UNBALANCED AGE OF MEDICAL FACILITIES

Characteristics of Malformed Population Aging

Malformed population aging in resource-exhaustion-type industrial towns mainly results from left-over aging workers and young workers working outside. When demands for coal resources were still huge, there were large numbers of miners in industrial towns, thereby forming quite many industrial villages. Most of these industrial villages were built in the second half of the 20th century. Compared with surrounding villages, they were foreign. Most of the residents in industrial villages were miners and their relatives. Though they come from rural places, they are still the part of people that "jumped out of villages". Therefore, most of the residents in industrial towns still lived in industrial communities after retirement instead of returning to their ancestral homes. Ever since the 1970s and the 1980s, a large number of retired and laid-off workers began to live here, which made population aging in industrial towns increasingly deteriorated. With the shrinking resources in mineral areas, capacity decreased gradually and so was the different degrees of shut-downs of mine areas; coal mining industries migrated outside gradually. Numerous workers in mining industry migrated to resource-growth and resource-maturity towns together with coal mining industry. When the cities were defined as resource exhaustion, major components of the population were the older generation of workers and parents and children of young miners, which promoted age structure to rise to population aging; finally, malformed population aging was formed.

Distribution of Medical Facilities in the Mining Areas

Most of the resource-type industrial towns were formed in growth or maturity period, and various public service supporting facilities were formed and completed during this period. Cities develop together with mining areas and the supporting medical service facilities configuration was also distributed according to the employment structure and residence structure at that time. District-level medical service facilities were established in large mining areas or towns of the mining bureau so as to be convenient for the large numbers of miners. Basic-level medical service facilities were also distributed according to small-scale independent mining areas. However, after the decline and shut-down of the mining areas, the residents' age structure, employment structure and residence structure have all changed. However, the previous medical service configuration has not changed, which resulted to the fact that provision cannot satisfy current demands.

CONCLUSION

This paper starts from two perspectives, which are medical facilities supply and residents' demands, and conducts a profound and comprehensive research analysis on the optimum aging of medical facilities in industrial towns. This paper takes Jiawang District in Xuzhou as an example and analyzes optimum aging configuration of medical facilities. The following parts are the enlightenments: as for medical facilities supply, its service scope should be considered comprehensively; overlapping service scope needs to be considered for the medical facilities configuration in the same area to avoid wasting of resources; as for configurations in different districts, degree of facilities should be considered reasonably to form service network for comprehensive utilization. Concerning residents' demands, demand subjects, i.e., senior citizens' actual going-out abilities should be combined; accessibility is regarded as demand, and then satisfactory indexes are obtained to analyze nearest going-out distance and judge the rationality of spatial distribution of the facilities. In the end, as for distribution optimization, social cost of facility configuration should be considered and minimum facility point model should be chosen in the hope of reaching maximum optimization benefits with minimum changing cost.

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