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An Empirical Analysis on the Influencing Factors of Per Capita Medical and Health Expenses

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Abstract

Since China entered the 20th century, the growth of population, the extension of life expectancy and the improvement of people's income level are the "troika" to promote the development of medical and health market. At present, China is the most populous country in the world. Although the population growth has slowed down in recent years, the population base is still huge, and the trend of population aging is gradually emerging. Since the founding of new China, with the continuous improvement of medical and health conditions, China's average life expectancy has been rising. At the same time, with the growth of per capita GDP, people's investment in health is increasing, the demand for diagnosis and treatment services is increasing, and the per capita medical expenses are also rising.

Keywords

Per Capita Health Cost; Influence Factor; Metrological Analysis.

1. Raising Question

Through various research data, the 21st Century Economic Research Institute found that China's health and medical service level, especially the high-end health and medical service level, is improving rapidly. In terms of the number of medical and health institutions, in 2009, the total number of medical and health institutions in China was 916571, which rose to 1007579 in 2019, an increase of 9.93% in 10 years. Among them, the number of hospitals increased rapidly, from 20291 in 2009 to 34354 in 2019, with an increase of 69.31% in 10 years. Then from the perspective of the number of health workers, it has also been rapidly improved in the past 10 years. The total number of health workers was 7781448 in 2009, which rose to 12928335 in 2019, an increase of 66.14% in 10 years. Finally, in terms of the number of beds in medical institutions, the total number in 2009 was 4.4166 million, which rose rapidly to 8.807 million in 2019 and reached 99.41% in 10 years; Among them, the number of beds in the hospital was 3.1208 million in 2009 and 6.8665 million in 2019, with an increase of 120% in 10 years.[1]

Another data can also explain the improvement of China's medical level: the total cost of health is growing rapidly. In 2009, China's total health expenditure was 1754.192 billion yuan, which reached 6584.139 billion yuan in 2019, an increase of 275.34% in 10 years. In 2019, China's per capita health expenditure has reached 4702.8 yuan.The improvement of China's medical level is progressing with the continuous advancement of urbanization. With the continuous flow of population into cities and towns, the demand for urban medical resources has increased, so that the growth of the number of hospitals far exceeds the growth of the overall number of health and medical institutions. At the same time, due to the high work pressure in the city as a whole, more attention is paid to health and health, which also increases the health cost and the demand for medical staff and beds.

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Meanwhile, in 2018, the total per capita health expenditure in Beijing reached 11609.06 yuan, which is the only area with more than 10000 yuan among 31 provinces, autonomous regions and cities. Shanghai ranked second, reaching 9495.89 yuan. The total per capita health expenditure of Beijing and Shanghai lags behind that of other provinces, autonomous regions and cities, and the per capita health expenditure of other provinces, autonomous regions and cities does not exceed 6000 yuan. Among them, Tianjin, which ranks third, has a per capita medical fee of 5698.41 yuan, only 1 / 2 of that of Beijing; Zhejiang ranked fourth, with 5433.29 yuan. It should be noted that although the per capita health expenditure is high, the proportion of personal health expenditure in Beijing and Shanghai is lower than that in the whole country, while the social health expenditure accounts for more than 50% of the total health expenditure.

At present, the proportion of social health expenditure in total health expenditure in China has increased year by year, reaching 44.27% in 2019. Social health expenditure refers to the capital investment of all sectors of society outside the government in health undertakings, including medical insurance, commercial health insurance, social donation assistance, etc. Due to the high cost of living, residents in big cities represented by Beijing and Shanghai pay more for medical and health care. At the same time, due to the comprehensive coverage of social insurance, developed commercial insurance and high sense of security, when the number of visits is more, individuals bear less proportion.

2. Theoretical Review

According to the white paper on China's medical and health undertakings (2012), China adheres to the health work policy of "focusing on rural areas, focusing on prevention, paying equal attention to both traditional Chinese and Western medicine, relying on science and technology and education, mobilizing the participation of the whole society, serving people's health and socialist modernization", and strives to develop medical and health undertakings with Chinese characteristics. Through unremitting efforts, a medical and health service system covering urban and rural areas has been basically formed, the ability of disease prevention and control has been continuously enhanced, the population covered by medical security has been gradually expanded, the level of Health Science and technology has been improved, and the health level of residents has been significantly improved.

Establish a medical and health system covering urban and rural areas. First, the public health service system. It includes professional public health service networks such as disease prevention and control, health education, maternal and child health care, mental health, health emergency, blood collection and supply, health supervision and family planning, as well as a medical and health service system based on the grass-roots medical and health service network and undertaking the function of public health services. Second, the medical service system. A rural three-level medical and health service network led by county-level hospitals and based on township hospitals and village clinics has been established in rural areas, and a new urban medical and health service system of division and cooperation between hospitals at all levels and community health service institutions has been established in cities. Third, the medical security system. This system takes basic medical security as the main body, supplemented by other forms of supplementary medical insurance and commercial health insurance. The basic medical security system includes the basic medical insurance for urban workers, the basic medical insurance for urban residents, the new rural cooperative medical system and urban-rural medical assistance, covering the urban employed population, the urban non employed population, the rural population and the urban and rural poor respectively. Fourth, the drug supply guarantee system. Including the production, circulation, price management, procurement, distribution and use of drugs.

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The level of health emergency response has been comprehensively improved. We promulgated laws and regulations such as the emergency response law and the emergency regulations for public health emergencies, revised the law on the prevention and control of infectious diseases, and promoted the legalization and standardization of health emergency work. Based on the disease prevention and control system, health supervision system and medical system, a health emergency system for public emergencies with unified command, reasonable layout, sensitive response, efficient operation and strong guarantee will be preliminarily established. Establish and improve the health emergency plan system, covering the prevention and control of public health emergencies such as sudden acute infectious diseases, unexplained diseases and poisoning events, as well as medical and health rescue and medical and health guarantee for major activities of natural disasters, accident disasters and terrorist events. Establish an emergency management system at the national, provincial (autonomous region, municipality directly under the central government), prefecture (city) and county levels. Establish the evaluation index system of health emergency response capacity. The state has established 27 national health emergency response teams in four categories: infectious disease control, medical rescue, poisoning disposal, nuclear and radiation disposal, and local governments have also established professional health emergency response teams for public emergencies at all levels. The national medical reserve system is becoming more and more perfect, which ensures the medical products needed to deal with public health emergencies.

In recent years, China has effectively handled public health emergencies such as SARS, H1N1, plague and human avian influenza, and launched emergency medical rescue in Sichuan, Wenchuan, Qinghai, Yushu and Gansu, Zhouqu, and the great floods and floods in Gansu Zhouqu.

3. Model Setting

Variable selection

Selection of explained variables:

The change of per capita health expenditure can better reflect the increase or decrease of medical expenses borne by people due to the change of other factors

Selection of explanatory variables:

The selection of explanatory variables should have a certain correlation with per capita medical expenses. At the same time, at the macro level, it is also worth exploring whether the increase of GDP has a certain external effect on the increase of per capita medical expenses.

Model setting

In order to verify the correlation between the above explanatory variables and the explained variables, the measurement model we adopted is:

$$Y= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X + u_t \quad (1)$$

Where, y is the per capita health cost (yuan); β 1 represents GDP (100 million yuan); β 2 represents the number of hospitals; β 3 represents health technicians (person); β 4 represents the number of beds in health institutions (10000)

4. Collection of Partial Data

data acquisition

In order to estimate the model parameters, the statistical data of per capita health expenditure, GDP, the number of beds in health institutions and the number of health technicians from 2000 to 2019 are collected, as shown in Table 1:

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Table 1. Per capita health expenditure and related data from 1999 to 2019

	GDP (100 million yuan)	Hospitals (PCs.)	Health technicians (person)	Number of beds in health institutions (10000)	Per capita health cost (yuan)
2000	100280.1	16318	4490803	317.7	361.88
2001	110863.1	16197	4507700	320.12	393.7983
2002	121717.4	17844	4269779	313.61	450.7509
2003	137422	17764	4380878	316.4022	509.4988
2004	161840.2	18393	4485983	326.8374	583.92
2005	187318.9	18703	4564050	336.75	662.3
2006	219438.5	19246	4728350	351.18	748.8391
2007	270092.3	19852	4913186	370.1076	875.96
2008	319244.6	19712	5174478	403.8707	1094.52
2009	348517.7	20291	5535124	441.6612	1314.26
2010	412119.3	20918	5876158	478.6831	1490.06
2011	487940.2	21979	6202858	515.9889	1806.95
2012	538580	23170	6675549	572.4775	2076.67
2013	592963.2	24709	7210578	618.1891	2327.37
2014	643563.1	25860	7589790	660.1214	2581.655
2015	688858.2	27587	8007537	701.5214	2980.798
2016	746395.1	29140	8454403	741.0453	3351.743
2017	832035.9	31056	8988230	794.0252	3783.831
2018	919281.1	33009	9529179	840.4078	4236.98
2019	990865.1	34354	10154010	880.6956	4702.789

Model Initial Estimation

Perform ordinary least squares regression according to the data in Table 1.

It can be seen from the analysis of main indicators that the determination coefficient is 0.9989 and the corrected determination coefficient is 0.9986, and the model fitting is good. The F statistic is 3497.643, which shows that the regression equation is obviously significant as a whole at the horizontal level. T-test shows that x1, X2 and X3 have significant effects on y. However, the t-test of X4 fails and the coefficient of X4 is contrary to expectations, indicating that there may be serious multicollinearity.

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Dependent Variable: Y
Method: Least Squares
Date: 12/20/21Time: 14:21
Sample: 2000 2019
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2859.915	201.2800	-14.20864	0.0000
X1	0.001206	0.000461	2.617371	0.0194
X2	0.079256	0.016015	4.948691	0.0002
X3	0.000626	0.000136	4.604556	0.0003
X4	-3.102623	1.457577	-2.128617	0.0503

R-squared	0.998929	Mean dependent var	1816.729
Adjusted R-squared	0.998643	S.D. dependent var	1379.475
S.E. of regression	50.80896	Akaike info criterion	10.90634
Sum squared resid	38723.26	Schwarz criterion	11.15527
Log likelihood	-104.0634	Hannan-Quinn criter.	10.95493
F-statistic	3497.643	Durbin-Watson stat	1.294064
Prob(F-statistic)	0.000000		

Figure 1. Ordinary least squares regression of model

Multicollinearity test

The multicollinearity is tested by the correlation coefficient test method, and the correlation coefficient matrix is shown in Figure 2:

Correlation

	X1	X2	X3	X4
X1	1.000000	0.985778	0.993119	0.995492
X2	0.985778	1.000000	0.990016	0.987080
X3	0.993119	0.990016	1.000000	0.998500
X4	0.995492	0.987080	0.998500	1.000000

Figure 2. Correlation matrix

It can be seen from the correlation coefficient matrix that the correlation coefficient between the explanatory variables is high, and there is serious multicollinearity.

Modified Multicollinearity

The stepwise regression method is used to test and solve the multicollinearity problem. The results are shown in Figure 3

Dependent Variable: Y
Method: Stepwise Regression
Date: 12/20/21 Time: 14:22
Sample: 2000 2019
Included observations: 20
Number of always included regressors: 1
Number of search regressors: 4
Selection method: Stepwise forwards
Stopping criterion: p-value forwards/backwards = 0.05/0.05

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	-3140.113	90.26394	-34.78813	0.0000
X3	0.000443	4.93E-05	8.987893	0.0000
X2	0.095228	0.016869	5.645034	0.0000

R-squared	0.998418	Mean dependent var	1816.729
Adjusted R-squared	0.998231	S.D. dependent var	1379.475
S.E. of regression	58.01422	Akaike info criterion	11.09673
Sum squared resid	57216.05	Schwarz criterion	11.24609
Log likelihood	-107.9673	Hannan-Quinn criter.	11.12589
F-statistic	5362.839	Durbin-Watson stat	0.926155
Prob(F-statistic)	0.000000		

Selection Summary

Added X3
Added X2

Figure 3. Correction of Multicollinearity

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Under the condition of significance level 0.05, the

$$Y=-3140.113+0.0004X_3+0.0952X_2$$
$$t=(-34.7881)\quad(8.9879)\quad(5.6450)$$
$$R^2=0.9984\quad \text{Adjusted } R^2=0.9982$$
$$F=5362.839\quad DW=0.9262$$

The model shows that the increase of per capita medical expenses is related to the number of hospitals and the number of health technicians.

5. Multicollinearity Test

Economic significance test

The estimation model shows that the per capita health cost is positively correlated with the number of hospitals and the number of health technicians, which is in line with the general significance of economics and passes the economic test Correlation coefficient test:[2]

Statistical inference test

Goodness of fit: in the data of OLS regression results, R2 = 0.9984, and the revised decisive coefficient is 0.9982, which shows that the model fits the sample data well as a whole.

F test: the significance level = 0.05, and the critical value of the difference degree of freedom (2,17) in the F distribution table is 3.59, because f = 5362.839 > 3.59, indicating that the regression equation is significant, that is, the combination of "number of hospitals" and "number of health technicians" does have a significant impact on "per capita health cost".

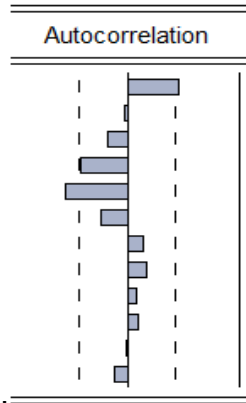
test: when the significance level = 0.05, the critical value of the degree of freedom of 17 in the t-distribution table is 2.110. From the above data, the corresponding t-statistics of x2 and X3 are 5.6450 and 8.9879 respectively, which shows that x2 and X3 have a significant impact on y when the significance level = 0.05.

Econometric test

Multicollinearity test: after modifying the model variables, the results of stepwise regression achieve the purpose of reducing multicollinearity. However, X1 represents GDP and X4 represents the number of beds in health institutions, which may lead to setting deviation.

Autocorrelation test

Date:12/20/21Time: 17:58
Sample: 2000 2019
Included observations: 20



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.475	0.475	5.2295	0.022
		2	-0.024	-0.323	5.2442	0.073
		3	-0.173	-0.006	6.0181	0.111
		4	-0.435	-0.479	11.233	0.024
		5	-0.579	-0.289	21.077	0.001
		6	-0.240	0.060	22.893	0.001
		7	0.144	0.065	23.597	0.001
		8	0.174	-0.186	24.711	0.002
		9	0.087	-0.320	25.017	0.003
		10	0.104	-0.134	25.493	0.004
		11	-0.016	-0.126	25.505	0.008
		12	-0.113	0.041	26.206	0.010

:

Figure 4. Partial correlation coefficient test results

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The test results of partial correlation coefficient show that the model has first-order and fourth-order autocorrelation, and the autocorrelation of the model needs to be remedied by Cochran oakt iterative method. The results are shown in Figure 5

Dependent Variable: Y
Method: ARMA Generalized Least Squares (BFGS)
Date: 12/20/21 Time: 18:05
Sample: 2000 2019
Included observations: 20
Convergence achieved after 5 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3108.542	113.3615	-27.42149	0.0000
X2	0.086162	0.018765	4.591617	0.0004
X3	0.000471	5.36E-05	8.782390	0.0000
AR(1)	0.793606	0.252674	3.140830	0.0067
AR(2)	-0.445854	0.258016	-1.728009	0.1045

R-squared	0.999028	Mean dependent var	1816.729
Adjusted R-squared	0.998768	S.D. dependent var	1379.475
S.E. of regression	48.41308	Akaike info criterion	10.84982
Sum squared resid	35157.40	Schwarz criterion	11.09876
Log likelihood	-103.4982	Hannan-Quinn criter.	10.89842
F-statistic	3852.774	Durbin-Watson stat	1.867737
Prob(F-statistic)	0.000000		

Inverted AR Roots	.40-.54i	.40+.54i

Figure 5. Statistical chart of multiple linear regression parameters

After five iterations, the model converges. After adjustment, the model DW = 1.8677, n = 20, k = 2. When the significance level = 0.05, the table is found to be = 1.10, = 1.537, and < 1.8677 = DW < 4 - = 2.463, indicating that there is no first-order autocorrelation in the model; Figure 5 shows that there is no higher-order correlation in the per capita health cost model (therefore, there is no higher-order correlation):

Date: 12/20/21 Time: 18:11
Sample: 2000 2019
Included observations: 20
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.009	0.009	0.0018	
		2	-0.297	-0.297	2.1552	
		3	0.280	0.314	4.1873	0.041
		4	-0.111	-0.283	4.5275	0.104
		5	-0.474	-0.318	11.129	0.011
		6	-0.070	-0.259	11.282	0.024
		7	0.043	-0.134	11.344	0.045
		8	-0.017	0.100	11.354	0.078
		9	0.020	-0.120	11.370	0.123
		10	0.082	-0.130	11.664	0.167
		11	-0.010	-0.313	11.669	0.233
		12	-0.026	-0.147	11.705	0.305

*Probabilities may not be valid for this equation specification.

Figure 6. Partial correlation coefficient test of modified model

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The regression model obtained from the figure is:

$$Y=-3108.542+0.0004X_3+0.0862X_2$$
$$t=(-27.4215)\quad(8.7824)\quad(4.5916)$$
$$R^2=0.999\quad \text{Adjusted } R^2=0.9988$$
$$F=3852.774\quad DW=1.8677$$

After the autocorrelation correction of the model, according to the results of the model, the per capita health cost is positively correlated with the per capita health cost and the number of health technicians. For every increase in the number of hospitals, the per capita medical cost increases by 0.0862 yuan, and for every increase of 0.0004% of health technicians, the per capita medical cost increases by 1%.

6. Conclusions and Recommendations

The increase of per capita medical expenses means the aggravation of people's medical burden. For Henan Province alone, the per capita medical expenses in Henan reached 3227.66 yuan in 2019. According to the statistical bulletin of national economic and social development of Henan Province in 2019, in 2019, the per capita disposable income of residents in Henan Province was 23902.68 yuan, the per capita consumption expenditure of residents was 16331.79 yuan, and the proportion of medical expenses in the total expenditure reached 19.8%. The annual per capita disposable income of Beijing residents was 67756 yuan, and the annual per capita consumption expenditure of Beijing residents was 43038 yuan, of which the per capita medical expenditure was 11609.06-yuan, accounting for 27.1%. It is not enough to reduce people's high burden on medical and health care only by increasing personal disposable income. Specific measures that can be implemented are also needed. Here are the following suggestions:

Continue to deepen the reform of the medical and health system, innovate mechanisms and create new highlights. Deepen the modern hospital management system and give full play to the functions of public hospitals in deepening medical reform. We will continue to control the unreasonable growth of medical expenses, strengthen monitoring and analysis, and implement the main responsibility. Accelerate the construction of national and provincial regional medical centers. Strengthen the construction of the general practitioner team, continue to focus on the construction of the medical consortium and the medical community, promote the two-way communication of medical personnel, unblock the referral channels of patients, open up telemedicine services, promote the upper level hospitals and grass-roots medical and health institutions to establish a linkage and division of labor cooperation mechanism, and promote the service level and service quality of grass-roots clinics.

Further improve the construction of grass-roots medical and health service system, and explore new development models such as community hospitals based on running at least one township health center and community health service center in each township and street. Strengthen the main responsibility of county-level governments in running hospitals and improve the environmental conditions for grass-roots medical treatment of urban residents. By raising the staffing allocation standard, strengthening the construction of talent team of medical team, strengthening the construction of infrastructure, strengthening the development of specialized departments of common diseases, continuously deepening reform, improving the management system and operation mechanism of grass-roots medical and health institutions, promoting the sinking of talent and technical resources, and improving the ability of grass-roots medical and health services.

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Further improve the construction of traditional Chinese medicine system and revitalize the development of traditional Chinese medicine. Implement the principle of paying equal attention to both Chinese and Western medicine, and give full play to the unique role of traditional Chinese medicine in building a basic medical system with Chinese characteristics; We will improve the TCM medical service system dominated by public TCM hospitals, jointly developed by non-public TCM medical institutions, and with outstanding grass-roots TCM service capacity. Comprehensively improve the medical service capacity of traditional Chinese medicine.

Strengthen epidemic prevention. According to the data released by the National Health Commission, the financial subsidy income received by China's professional public health institutions in 2018 was about 124.3 billion yuan, less than half of that of hospitals, and the proportion of financial subsidies received by professional public health institutions in all health institutions has shown a downward trend in recent years. Insufficient financial allocation leads to brain drain. From 2005 to 2018, the number of staff of China Center for Disease Control and prevention decreased from 206500 to 187800, with an average annual decrease of 0.73%. The emergency management ability of CDC is directly related to health and epidemic prevention and public health safety.

The epidemic situation in 2020 has sounded the alarm for us. The disease prevention work still needs to be done earnestly. At the same time, we should strengthen the infrastructure construction in the field of medical and health care. It is only discussed in Wuhan, where the epidemic occurred. Due to the shortage of beds in Wuhan, Leishen mountain and Huoshen mountain hospitals are temporarily built. If the local beds are sufficient, patients can have bed arrangements at the first time of diagnosis, to further improve work efficiency and reduce the risk of infection.

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