A Study on Equalization of Basic Medical Services in Shanghai Based on Factor Analysis

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***Abstract*—Purpose: This paper comprehensively evaluates whether the districts in Shanghai realize the equalization of basic medical services and aims at providing the reference for the health planning. Approaches: The author adopts SPSS software to conduct factor analysis on each index. Results: The districts with satisfying equalization of basic medical services concentrate in the central urban areas, among which Jing'an District, Xuhui District, Huangpu District and Changning District have the best equalization. Besides, there is obvious non-equalization in the districts far away from the central urban area. Among them, Qingpu District, Chongming District, Jinshan District and Jiading District have the most serious non-equalization status. Conclusion: Generally speaking, the non-equalization of basic medical services in Shanghai is quite unsatisfying.**

Keywords- basic medical services; equalization; factor analysis

I. SIGNIFICANCE OF THE STUDY EQUALIZATION OF MEDICAL SERVICE

At present, our economic society has entered the essential period of accelerating transformation. As a result, it is necessary to put realizing the equalization of public services on the agenda of social construction. Under this situation, it appears more practical to protect the vital interests of the masses for the equalization of public services. In the meantime, it also enables the government to realize the importance of transforming functions. However, due to the influence of the previous economic development and the inadequate financial investment and so on, the supply amount and quality structure of public products are not reasonable, which cannot satisfy the people's demands under the new situation. As an important component of public services, the medical service still falls behind the development of economy and other social careers. It is faced with the predicaments such as the non-equalization of supply in urban and rural areas.

Under the joint cooperation with each department, Shanghai is gradually improving the medical health. It has made outstanding achievements in "5+3+1" Project, joint regional medical care, high-end medical care, information construction and the policy promotion such as the household doctor policy and so on. However, as a large city with an accumulated number of external populations, there is still non-equalization of basic medical services in different districts in Shanghai. As a consequence, under the big social background, it is of great urgency and research significance to solve the non-equalization problem of basic medical services. [1]

II. CONSTRUCTION OF FACTOR ANALYSIS MODEL

A. Construction of Index System

In accordance with the design of the indexes of equalization of basic medical services in Shanghai, the author selects 15 most typical indexes for the assessment and analysis of the equalization of basic medical services in the districts in Shanghai [3]. They are respectively:

x1→the number of health institutions for each ten thousand people
x2→the number of beds for each ten thousand people
x3→the number of health technicians for each ten thousand people
x4→the number of doctors for each ten thousand people
x5→the number of nurses for each ten thousand people
x6→the expenditure of health investment (RMB: yuan)
x7→emergency treatment every day
x8→the average number of hospitalized patients every day
x9→the utilization ratio of sickbeds (%)
x10→the average hospitalization time (day)
x11→the average medical expense on each emergency treatment (RMB: yuan)
x12→the death ratio of babies (%)
x13→the death ratio of the pregnant (%)
x14→the health care coverage among children (%)
x15→the immunization ratio among children (%)

Because the health technicians not only refer to doctors and nurses, but also include other people whose work is related to medical care such as pharmacists [4]. Therefore, when we conduct factor analysis and extract public factors, the correlation degree of each public factor is quite low, which accords with the presumptions of the analysis. We can apply the method into the analysis.

B. Standaedized Treatment

Because the different dimensions of observed variables and varied orders of magnitude will lead to inaccuracy, we need to carry out standardized treatment on the data first [5]. We import the original data and choose standardized treatment. Thereby, we can get the handled data.

TABLE I 。 RESULTS OF INDEX STANDARDIZEDD TREAMENT (a)

District	x_1	x_2	X_3	x_4	x_5	x_6	x_7
Huangpu District	1.42908	1.64296	1.6614	1.66969	1.58738	-0.21155	3.81152
Xuhui District	0.72392	1.12363	0.84787	0.76545	0.83521	-0.33015	0.05256
Changning District	1.29896	0.14077	0.34736	0.3404	0.31117	-0.36887	-0.22874
Jing'an District	2.83233	2.86448	3.01874	3.03499	3.07807	-0.44512	-0.20227
Putuo District	-0.57397	-0.41036	-0.4199	-0.42921	-0.42392	-0.31562	-0.18833
Jiabei District	-0.30989	-0.03271	-0.20114	-0.21428	-0.18997	-0.33614	-0.46112
Hongkou District	-0.14578	0.20527	0.10877	0.19482	0.07214	1.46044	-0.15665
Yangpu District	-0.48899	-0.16502	-0.26222	-0.29865	-0.2105	-0.27302	-0.1055
Pudong New District	-0.56795	-0.646	-0.56533	-0.55815	-0.56899	-0.41063	0.26138
Minxing District	-0.58939	-0.68059	-0.61862	-0.6366	-0.60085	3.47963	-0.15412
Baoshan District	-0.44681	-0.69765	-0.60478	-0.61266	-0.58954	-0.19125	-0.44
Jiading District	-0.31268	-0.82043	-0.65197	-0.62048	-0.64402	-0.41063	-0.2937
Jinshan District	-0.28174	-0.24167	-0.32775	-0.34464	-0.30188	-0.45582	-0.38779
Songjiang District	-0.73372	-0.74072	-0.65523	-0.62736	-0.66061	-0.13833	-0.33651
Qingpu District	-0.64813	-0.80607	-0.64539	-0.65636	-0.62672	-0.36762	-0.3939
Fengxian District	-0.99936	-0.4242	-0.59115	-0.58893	-0.60198	-0.42492	-0.38013
Chongming County	-0.18587	-0.3117	-0.44066	-0.41803	-0.46499	-0.26042	-0.39668

TABLE I. RESULTS OF INDEX STANDARDIZEDD TREAMENT (b)

District	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
Huangpu District	0.98759	-0.15722	-0.43281	0.91949	-0.81326	-0.59768	0.03502	0.40912
Xuhui District	-0.02308	1.0116	0.42753	0.41793	0.83352	-0.59768	-0.51883	-0.66343
Changning District	0.04571	-0.01696	0.07217	1.51543	-0.05724	-0.74583	-0.24191	-0.66343
Jing'an District	1.50686	0.5581	-1.37544	1.47857	-0.59619	-0.74583	0.00179	0.98665
Putuo District	1.59396	-0.12605	-1.08367	0.37074	0.51165	-0.74583	0.86581	0.98665
Jiabei District	0.16895	0.8168	-0.51136	-0.71939	-1.04531	-0.74583	-0.24191	-0.66343
Hongkou District	0.04731	0.54407	-0.69465	-0.69542	-1.03782	-0.74583	0.03502	-2.31351
Yangpu District	-0.35611	1.44796	0.90633	1.9029	-0.63361	0.17068	0.69965	0.82164
Pudong New District	-0.34382	-0.60916	0.20309	0.91028	0.04755	0.5361	0.61657	0.92065
Minxing District	-0.8866	1.08485	1.32527	-0.6781	0.26463	-0.22634	0.75504	0.90415
Baoshan District	-0.96047	0.14356	0.49112	-0.83552	0.10744	0.14896	0.71904	0.38437
Jiading District	-1.07663	-1.5037	1.69933	-0.53063	-0.35666	0.72572	0.86581	0.98665
Jinshan District	-1.09057	-0.8663	1.32527	-0.6969	-0.60367	1.62446	-0.24191	-1.48847
Songjiang District	1.13805	-0.21644	-1.83928	-1.09468	0.50416	-0.74583	0.31195	-0.66343
Qingpu District	-1.16084	-2.57589	-0.54503	-0.6228	3.07913	0.7356	-3.28812	-0.66343
Fengxian District	1.46007	0.54407	0.57715	-0.66335	-0.85069	2.70096	0.56119	0.80514
Chongming County	-1.05039	-0.0793	-0.54503	-0.97856	0.64638	-0.74583	-0.93423	-0.0859

C. *Matrix of Correlated Coefficient*

Through calculating the correlation of each index variable, we can get the following correlation table:

TABLE II. CORREALATION MATNIX AMONG THE VARIABLES (a)

Correlations							
	Zscore x1	Zscore x2	Zscore x3	Zscore x4	Zscore x5	Zscore x6	Zscore x7
Zscore x1	1	.919**	.952**	.951**	.950**	-.171	.390
Zscore x2	.919**	1	.990**	.988**	.989**	-.151	.451
Zscore x3	.952**	.990**	1	.999**	.999**	-.148	.455
Zscore x4	.951**	.988**	.999**	1	.999**	-.142	.456
Zscore x5	.950**	.989**	.999**	.999**	1	-.149	.436
Zscore x6	-.171	-.151	-.148	-.142	-.149	1	-.028
Zscore x7	.390	.451	.455	.456	.436	-.028	1
Zscore x8	.335	.486*	.473	.477	.467	-.199	.265
Zscore x9	.172	.338	.263	.255	.265	.337	.003
Zscore x10	-.279	-.335	-.347	-.359	-.341	.204	-.091
Zscore x11	.601*	.550*	.576*	.566*	.579*	-.255	.340
Zscore x12	-.213	-.309	-.271	-.281	-.269	-.042	-.210
Zscore x13	-.443	-.374	-.387	-.390	-.379	-.182	-.182
Zscore x_{14}	-.075	-.038	-.043	-.040	-.042	.193	.059
Zscore x_{15}	.039	.028	.067	.060	.076	-.048	.144

TABLE II. CORREALATION MATNIX AMONG THE VARIABLES (b)

Correlations								
	Zscore x8	Zscore x9	Zscore x10	Zscore x11	Zscore x12	Zscore x13	Zscore x14	Zscore x15
Zscore x1	.335	.172	-.279	.601*	-.213	-.443	-.075	.039
Zscore x2	.486*	.338	-.335	.550*	-.309	-.374	-.038	.028
Zscore x3	.473	.263	-.347	.576*	-.271	-.387	-.043	.067
Zscore x4	.477	.255	-.359	.566*	-.281	-.390	-.040	.060
Zscore x5	.467	.265	-.341	.579*	-.269	-.379	-.042	.076
Zscore x6	-.199	.337	.204	-.255	-.042	-.182	.193	-.048
Zscore x7	.265	.003	-.091	.340	-.210	-.182	.059	.144
Zscore x8	1	.338	-.607**	.307	-.321	-.175	.304	.206
Zscore x9	.338	1	.014	.273	-.561*	-.303	.527*	.104
Zscore x10	-.607**	.014	1	-.026	-.174	.565*	.264	.195
Zscore x11	.307	.273	-.026	1	-.191	-.227	.166	.355
Zscore x12	-.321	-.561*	-.174	-.191	1	-.038	-.696**	-.038
Zscore x13	-.175	-.303	.565*	-.227	-.038	1	.010	.152
Zscore x_{14}	.304	.527*	.264	.166	-.696**	.010	1	.455
Zscore x_{15}	.206	.104	.195	.355	-.038	.152	.455	1

D. *Result analysis*

1) *Communalities of variables*

In the table below, the extraction factors in the third row can explain the scale of independent variables with the value ranging from 0-1. The bigger the value is, the higher the correlation degree is. As shown in table 3, in the extraction row, except that the death ratio of babies is quite low, the other values are above 0.5, which indicates that the variables share sound communalities. We can carry out modeling analysis.

TABLE III. COMMUNALITIES OF VATIABLES

Communalities		
	Initial	Extraction
Zscore x_1	1	0.932
Zscore x_2	1	0.96
Zscore x_3	1	0.979
Zscore x_4	1	0.977
Zscore x_5	1	0.974
Zscore x_6	1	0.679
Zscore x_7	1	0.864
Zscore x_8	1	0.958
Zscore x_9	1	0.587
Zscore x_{10}	1	0.882
Zscore x_{11}	1	0.544
Zscore x_{12}	1	0.307
Zscore x_{13}	1	0.768
Zscore x_{14}	1	0.657
Zscore x_{15}	1	0.642
Extraction Method: Principal Component Analysis.		

2) Eigenvalue and accumulated contribution ratio

In the table below, according to the regulation that the eigenvalue of selected public factors cannot be below 1, only 4 public factors are eligible. The variance proportions within the first, second, third and fourth factor's explanation reaches 42.34%, 16.569%, 10.533% and 8.611%. The accumulated contribution rate reaches 78.053%.

TABLE IV. EIGENVALES AND ACCUMULATED CONTRIBUTION RATE

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.351	42.34	42.34	6.351	42.34	42.34
2	2.485	16.569	58.909	2.485	16.569	58.909
3	1.58	10.533	69.442	1.58	10.533	69.442
4	1.292	8.611	78.053	1.292	8.611	78.053
5	0.989	6.595	84.648			
6	0.816	5.44	90.088			
7	0.615	4.098	94.185			
8	0.411	2.738	96.923			
9	0.256	1.708	98.632			
10	0.116	0.772	99.404			
11	0.056	0.372	99.776			
12	0.031	0.209	99.984			
13	0.002	0.014	99.998			
14	0	0.002	100			
15	9.72E-06	6.48E-05	100			
Extraction Method: Principal Component Analysis.						

In order to better reflect the actual meaning of each public factor, the accumulated contribution rate of the public factors should reach more than 80%. The most ideal rate is more than 85% [6]. Therefore, we need to modify the above indexes and eliminate the indexes with low correlation degree. Through the observation of the communalities of the variables, we first get rid of the death ratio of babies (x12) with a low correlation degree. Besides, the loading coefficient of the utilization ratio of sickbeds (x9) and the average number of patients in emergency treatment every day (x7) on the public factors is also low, so we get rid of them, too.

E. Model Modification

Through analyzing the results of operating the model, we get rid of the average number of patients in emergency treatment every day (x7), the utilization ratio of sickbeds (x9), the death ratio of babies (x12) and the death ratio of the pregnant (x13). Then we re-calculate and re-analyze the data, we can get the following results:

1) Eigenvalue and accumulated contribution ratio

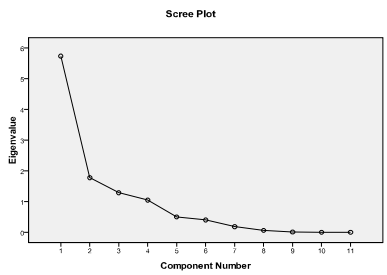
After we modify the data, we can get the table of modified eigenvalue and accumulated contribution rate. The public factors can more mildly explain the variance of the indexes after rotation. The explanation of the public factors before the rotation is quite steep. The proportion occupied by the first factor is excessive [7]. After rotation, although the proportion is still large, the gap between the second factor is narrowed down; and the gap is relatively moderate. The variance proportion with the first, second, third and fourth factor is respectively 47.678%, 16.190%, 15.030% and 10.596%. The accumulated contribution rate reaches 89.494%. It indicates that the indexes can better reflect the actual meaning and explain the information of the original variables.

TABLE V. MODIFIED EIGNEVALUE AND ACCUMULATED CONTRIBUTION RATE

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	CumulaTive %
1	5.732	52.106	52.106	5.732	52.106	52.106	5.245	47.678	47.678
2	1.777	16.156	68.261	1.777	16.156	68.261	1.781	16.190	63.868
3	1.287	11.702	79.964	1.287	11.702	79.964	1.653	15.030	78.898
4	1.048	9.530	89.494	1.048	9.530	89.494	1.166	10.596	89.494
5	.501	4.554	94.048						
6	.401	3.641	97.689						
7	.184	1.674	99.362						
8	.062	.560	99.922						
9	.008	.068	99.990						
10	.001	.008	99.999						
11	.000	.001	100.000						

2) Scree plot

From the scree plot, we can clearly see the variance proportion within 11 indexes' explanation. There are turning points at Index 2 and 5. Moreover, according to the principle that the eigenvalue should be above 1, we select the former 4 most representative factors as the public factors.



FGURE I 。MODIFIED SCREE PLOT

3) Public factor

If we rotate the loading coefficient matrix of the modified and non-rotated public factors, we sequence each column in the loading matrix according to the scale of the loading coefficient in order to draw conclusions more easily so that we can gather the variables with high loads of the same public factor. The results are shown in Table 6.

TABLE VI. LOADING COEFFICIENT MATRIX OF MODIFIED AND ROTATED PUBLIC FACTORS

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
x_5	.976	.018	.190	-.043
x_3	.975	.012	.198	-.040
x_4	.973	.008	.210	-.030
x_1	.964	-.026	.070	-.087
x_2	.962	-.002	.210	-.028
x_{11}	.631	.419	-.096	-.372
x_{14}	-.063	.844	.086	.295
x_{15}	.051	.825	-.078	-.184
x_{10}	-.190	.293	-.863	.121
x_8	.311	.351	.833	-.070
x_6	-.068	.043	-.152	.935

And then we use SPSS software to proceed with the factors, we can get the values of F1,F2,F3 and F4 in the districts in Shanghai. The details are shown in the table below:

TABEL VII .CORRESPONDING VALUES OF PUBLIC FACTORS IN THE DISTRICTSIN SHANGHAI

District	F_1	F_2	F_3	F_4
Huangpu District	1.55885	0.27673	0.37959	-0.04868
Xuhui District	0.95908	-0.55937	-0.48647	-0.16577
Changning District	0.68033	-0.18602	-0.45613	-0.62255
Jing'an District	2.83506	0.38341	0.85911	-0.15685
Putuo District	-0.72835	1.20411	1.60934	-0.42143
Jiabei District	-0.34238	-0.59198	0.59751	-0.05882
Hongkou District	0.11416	-1.30034	0.69218	1.8939
Yangpu District	-0.02179	1.23879	-0.996	-0.8268
Pudong New District	-0.51045	0.97411	-0.37014	-0.79163
Minxing District	-0.2633	0.80193	-1.08889	2.99196
Baoshan District	-0.61853	0.31443	-0.52309	0.02084
Jiading District	-0.51675	0.88643	-1.38491	-0.32105
Jinshan District	-0.16275	-0.94654	-1.14799	-0.05627
Songjiang District	-1.08858	-0.31595	2.13618	0.22631
Qingpu District	-0.59436	-2.24007	-0.46375	-1.10028
Fengxian District	-0.87253	1.00766	0.78942	-0.25842
Chongming County	-0.42769	-0.94734	-0.14596	-0.30445

Finally, we calculate the comprehensive scores of each factor. The method is: treat the proportion of the single variance contribution rate to the total variance contribution rate as the weight to carry out weight summarization. We can get the comprehensive score F of the districts in Shanghai, i.e.: $F=(47.678\times F_1+16.190\times F_2+15.030\times F_3+10.596\times F_4)/89.494$。

The comprehensive scores of basic medical services in the districts in Shanghai are shown in Table 8 below.

TABLE VIII .SCORE & RANKING OF COMPREHENSIVE EVALUATION OF THE DISTRICTS IN SHANGHAi

District	F	Ranking
Huangpu District	1.705453318	1
Xuhui District	0.938526979	2
Changning District	0.30843043	3
Jing'an District	0.178480527	4
Putuo District	0.176172936	5
Jiabei District	0.16606304	6
Hongkou District	0.050184119	7
Yangpu District	-0.05266885	8
Pudong New District	-0.18056748	9
Minxing District	-0.19611182	10
Baoshan District	-0.25154515	11
Jiading District	-0.25161139	12
Jinshan District	-0.35802259	13
Songjiang District	-0.38553811	14
Qingpu District	-0.45740054	15
Fengxian District	-0.45979138	16
Chongming County	-0.93004401	17

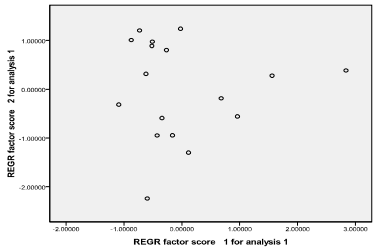


FIGURE II .SCATTER DIAGRAM OF SCORES OF COMPREHENSIVE EVALUATION OF BASIC MEDICAL SERVICES IN DISTRICTS IN SHANGHAI

III. EVALUATION ON RESULTS

We can see from Table 6 that the load value of the public factor F1 on x1 (the number of health institutions for each ten thousand people), x2 (the number of beds for each ten thousand people), x3 (the number of health technicians for each ten thousand people), x4 (the number of doctors for each ten thousand people) and x5 (the number of nurses for each ten thousand people). These indexes all reflect the configuration condition of basic human resources and material resources of the health institutions of one region. As a result, F1 is the public factor which reflects the scale of the medical institutions and the condition of human resources. The higher the score of the factor is, the larger the scale of the medical institution is and the more adequate the configuration of human resources is. The load value of the public factor F2 on x14 (the coverage of children health care) and x15 (the immunization ratio among children) are quite large. These indexes reflect the reachability and accessibility of the basic public health services in one area. Therefore, F2 is the factor which reflects the reachability and accessibility of the basic public health services. The higher the score of the factor is, the larger the coverage scale of the public health services in this area is and the better the public health care is. The load value of the public factor F3 on x8 (the average number of hospitalized patients every day) and x10 (the average hospitalization time) is quite large. These indexes mainly reflect the efficiency of the medical institution in one area. Therefore, the higher the score of the factor is, the

higher the efficiency of the medical institution is. The load value of the public factor F4 on x6 (the expenditure of health investment) is quite large. It mainly reflects the intensiveness of the expense on the medical health career by the local finance. Therefore, the higher the score of the factor is, the higher the financial investment force of the government is.

The former 5 districts with the highest scores in terms of the scale and human resources of medical institutions are respectively Jing'an District, Huangpu District, Xuhui District, Changning District and Hongkou District. Among the districts, the scores of Jing'an and Huangpu are 2.84 and 1.56 respectively, which are higher than the scores of other cities, which indicates that in terms of the scale of medical institutions and configuration of human resources, the scale of medical institutions and configuration of human resources in Jing'an and Huangpu are superior to those in other districts and counties. The districts and counties with a small scale of medical institutions and poor configuration of human resources include Songjiang District and Fengxian District. The districts with higher score in F2 include Yangpu District, Putuo District and Fengxian District; and the districts with low score include Qingpu District and Hongkou District, which indicates that Qingpu District and Hongkou District still shoulder heavy responsibilities in terms of the public health services. The districts with high score in F3 include Songjiang District and Putuo District, which indicates that the efficiency of the medical institutions in the two districts is superior to that in other districts and counties. However, the efficiency of the medical institutions in Jiading District, Jinshan District and Minxing District still needs further promotion. Minxing District and Hongkou District achieve high score in F4. The government has invested a large amount into the health. On the opposite, Qingpu District and Yangpu District have inadequate investment into health, which rank at the last two positions.

According to the comprehensive scores, we can evaluate the equalization of basic medical services in the districts in Shanghai comprehensively. The first five districts in terms of the comprehensive scores include Jing'an District, Huangpu District, Xuhui District, Changning District and Minxing District. The four districts with lowest comprehensive scores include Qingpu District, Chongming County, Jinshan District and Jiading District. After combining with the score of each factor for analysis, we can find that although Jing'an District ranks first in terms of the scale of medical institutions, configuration of human resources and the efficiency of the hospital, the investment in health and public medical care still requires for further improvement. Minxing District needs to further optimize the scale of medical institutions and human resources. In addition, in terms of medical institutions and configuration of human resources, the districts in the central urban areas are obviously superior to those in the suburbs. As shown in the diagram of the factor scores, we can see that only a few districts' equalization of basic medical services is concentrated; and the equalization of other districts is quite scattered. Besides, a few districts are in the third quadrant. As a result, it is an important topic to figure out how to accelerate the basic medical services in the districts in Shanghai, which exerts influence on the healthy development of Shanghai.

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REFERENCES

[1] Samuelson, Economics [M], Beijing: China Renmin University Press, 2003: p167-193.

[2] Li Jingjing, Research on Equalization of Basic Medical and Health Service between Urban and Rural Areas in China [D], 2010.6

[3] Lai Yong, A Study of Dilemma and Solution of Guangxi's Rural Health Care Reform from the Perspective of Basic Medical Service Equalization [D], 2012.4