Analysis of the Influencing Factors of Smart Medical Industry in the Context of Big Data

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Abstract—Over the past decades of medical reform, "Internet+" technology has continued to penetrate into daily life, and smart medical care has emerged. Smart medical care can further promote the development of Internet medical care in China, improve the efficiency of treatment, and effectively solve the problem of "difficult and expensive to see a doctor". This paper explores the factors influencing the development of smart medical care in China from the perspective of users through questionnaire surveys and data analysis. Based on the survey data, logistic regression analysis was used to investigate three aspects: the influence of epidemic, personal characteristics, and the economic and medical level. It was found that users have certain knowledge about smart medical care and its further development is of great concern; there are significant differences between age, occupation, and health condition and whether they use smart medical care regularly; there are significant effects of smart patents and regionalization of Internet hospitals on the market size of smart medical care in each province.

Keywords-smart medical care; healthcare informatization; multivariate logistic model; big data

1. Introduction

In the past decade, the share of personal health expenditure of Chinese residents has decreased from 34.34% in 2012 to 27.7% in 2021, and average life expectancy has increased from 74.4 years in 2012 to 78.2 years in 2021, and the standard of per capita financial subsidies for residents' medical insurance has increased from 240 yuan to 610 yuan. It shows that China's healthcare industry and medical standards have been continuously enhanced, and people's happiness of living a better life has been increasing. The emergence of big data, cloud computing, and the Internet has promoted the rapid development of "Wise Information Technology of med" (WITMED), facilitating the sharing and exchange of medical information and resources, realizing telemedicine services, and easing the pressure of medical resource shortage. However, the shortcomings of personal privacy leakage, uneven distribution of data resources, and uneven data analysis and processing capabilities make the smart medical system still suffer from low information integration, low inefficient usage, and imperfect basic service system. In this regard, an in-depth analysis of the current situation of WITMED in the general environment of the epidemic, users' attitudes and views on WITMED, and the development of WITMED in each province of China will be of far-reaching significance in improving the use

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efficiency, perfecting the basic theory, and building a comprehensive healthcare service system.

2. Introduction of Smart Medical System

Smart medical system is usually composed of three parts (Fig 1): smart hospital system, regional health system and family health system [1], through the construction of regional medical archives medical information platform, the use of IOT, cloud computing and the Internet to achieve the communication between patients and medical staff, hospitals, equipment, and gradually realize the digitalization, informatization and intelligence of the medical system [2]. Data shows that in 2020, the scale of China's smart medical industry has exceeded the 100 billion yuan mark, and the smart medical industry will get a rapid development of intelligence and digitalization. With the digital economy gradually permeating into life, the scale of China's smart medical market is growing at a high speed, ushering in a good time for development across the board, and its market size is expected to reach 157.6 billion yuan in 2022.

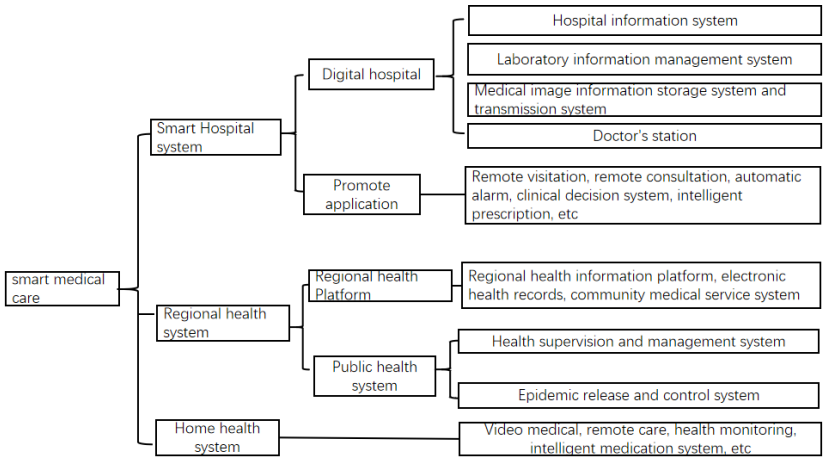

Figure 1 Components of a Smart Medical System

3. Influencing factors of the development of smart medical services

Despite the rapid development of the smart medical industry, it is still in its infancy, and there is a huge potential of output value to be explored. As there are many factors affecting the development of smart medical services, using the Delphi method, the following seven factors were selected, namely the impact of the epidemic, the degree of people's acceptance and use of smart medical care, GDP of each province, the number of Grade A tertiary hospitals, the number of smart hospitals assessed at level 3 and above, the regionalization of Internet hospitals and the number of smart patents, and divided into three aspects: the impact of the epidemic, personal traits, and the level of economy and medical care to analyze the development of smart medical services.

3.1 Impact of the epidemic on the smart medical care services

In 2020, a sudden epidemic broke the rhythm of people's lives. After the outbreak, major hospitals were occupied by COVID-19 patients, while non-infected patients were consciously quarantined at home, and offline medical channels were almost completely cut off. As can be seen in Figure 2, during the Chinese New Year in 2020, the number of online consultation daily activities reached 6.712 million. Compared with 2019, the number of online consultation daily activities in a single day increased by almost 1.6 million, nearly 1.3 times. At the same time, a number of online medical service platforms also treat patients online, and the major online consultation platforms have also ushered in a new wave of development. 39 Health Network was visited at the million level every day; Ali Health consultation page was visited by 11.16 million users, and the cumulative online consultation volume exceeded 1.04 million (Table 1). This shows that, due to the epidemic, in addition to a significant increase in the number of online consultations, hospitals have also accelerated their entry into information technology.

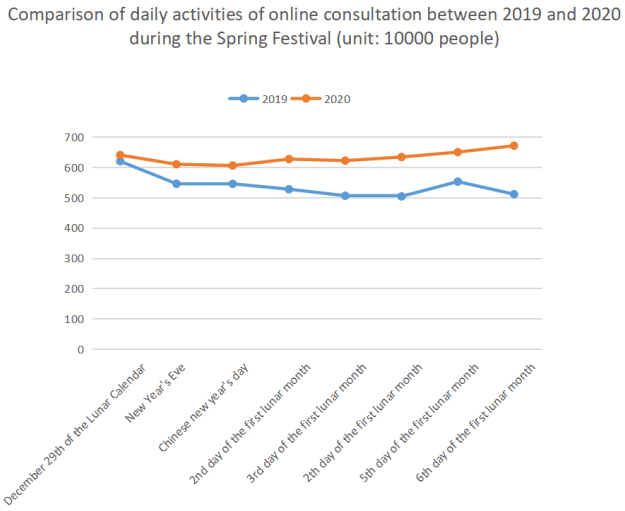

Figure 2 Comparison of daily activities of online consultation between 2019 and 2020

Table 1 Online medical treatment reception on online medical platforms during the epidemic

platform	Online consultation
39 health network	The website receives millions of visitors every day.
Ali health	During the spring festival, its consultation page had attracted 11.16 million visitors and more than 1.04 million online consultations.
Spring rain doctors	As of 17 PM on February 25, the online free clinic service launched by the platform has accumulated more than 1.5 million users, 60% of which are new users. During the period of free consultation, the average daily consultation volume increased by nearly 100%.
Micro medical	The real-time COVID-19 relief platform has been launched. As of 9:00 am on February 25, the platform has received more than 116 million visits, and 41,196 As of 9:00 am on February 25, the platform has received more than 116 million visits, and 41,196 doctors have been recruited to provide online medical consultation services for 1.437,100 people.
DXY	The number of online consultation users increased by 215.32% and the number of consultation volume increased by 134.91%.

platform	Online consultation
Good doctor	By February 19, the platform's online consultation service had reached 1.68 million person-times, with a month-on-month increase of nearly 6.5 times.
Medlinker	As of Feb 8, the anti-coronavirus online consultation platform had served 198,000 patients
The deer medical library	A TCM diagnosis and treatment platform, as of February 10, contacted more than 1,126 TCM experts to provide free consultation services, receiving 3,623 A TCM diagnosis and treatment platform, as of February 10, contacted more than 1,126 TCM experts to provide free consultation services, receiving 3,623 consultations in total.
Penguin Doctor Platform	By February 8, more than 5,000 doctors had participated in free consultations and helped a million families self-isolate at home.
Micro pulse platform	Since January 21, Wemai APP has received 42.34 million visits and more than 720,000 visits.

3.2 Personal traits

3.2.1 Objects and methods

In this study, a convenience sampling method was used, and 312 questionnaires were distributed through a combination of offline random chance encounters and online questionnaires, of which 278 were valid and 34 invalid questionnaires were excluded, with an effective rate of 89%. After recording the data, a multivariate logistic model was used to deeply analyze people's acceptance and frequency of using smart medical APP.

3.2.2 Establishment of model

The logistic regression analysis specifies that the dependent variable is a categorical variable, and the dependent variable is divided into binary logistic, ordered logistic and unordered logistic. The "frequency of use of smart medical APP" is set as the dependent variable and ordered logistic analysis is adopted. When "never use" is selected, yi is 0, when "often use" is selected, yi is 1, when "occasionally use" is selected, yi is 2. The large amount of data in the questionnaire set up for this survey are categorical variables (Figure 3), such as occupation, and there is no quantitative high or low between them, so it is not possible to give a separate regression coefficient estimate for them to indicate the trend of the dependent variable. For the setting of the baseline class, the last option was set as the baseline class by default. Incorporating all the variables to be considered, a multivariate choice logit model shaped as follows:

$$Y=\beta_0+\beta_1 Gender+\beta_2 Age\_Below18+\beta_3 Age\_18\text{-}30+\beta_4 Age\_31\text{-}45+\beta_5 Age46\text{-}60+\beta_6 PrimarySchoolOrBelow+\beta_7 Junior+\beta_8 Senior+\beta_9\ Gover+\beta_{10}\ Enterpeise+\beta_{11}\ Teacher+\beta_{12} Student+\beta_{13}\ Individual+\beta_{14}\ Others+\beta_{15}\ Healthy+\beta_{16}\ Good+\beta_{17}\ Common \quad (1)$$

Respondents' acceptance and use of smart medical system (n=278)			
variable	category	frequency(number)	percentage(%)
gender	male	125	45.00%
	female	153	55.00%
age	Below 18	7	2.40%
	18-30	147	53.00%
	31-45	70	25.20%
	46-60	33	11.80%
	Over 60	21	7.60%
educational level	Primary school or below	10	3.60%
	junior	27	9.70%
	senior	76	27.30%
	college	161	57.90%
occupation	Government officials	4	1.40%
	Enterprise personnel	61	22.00%
	teacher	24	8.70%
	student	91	32.90%
	self-employed individual	32	11.40%
	others	45	16.10%
	farmer	21	7.50%
health condition	healthy	94	33.80%
	good	117	42.20%
	common	53	19.10%
	bad	14	4.90%

Figure 3 respondents' acceptance and use of smart medical system (n=278)

3.2.3 Results and Analysis

The data were selected for multivariate logistic analysis using SPSS 27.0, and the statistical significance level was 0.05, when the statistical result was less than 0.05, the statistical result was significant. From the results of the model fitting information, it can be obtained that the selected independent variables are significantly different from the dependent variable with significance <0.05. According to the probability values of the statistics estimated by the great likelihood, the regression results are shown in Fig 4 and Fig 5.

	model fitting condition	likelihood ratio test		
model	-2 log likelihood	chi-square	freedom	significance
Intercept only	556.251			
finally	139.977	416.274	146	.000

Figure 4 Model fitting information

likelihood ratio test				
	model fitting condition	likelihood ratio test		
effect	-2 log likelihood	chi-square	freedom	significance
intercept	139.977	.000	0	.
gender	140.728	.751	2	.687
age	370.127	230.150	120	.000
academic degree	146.643	6.666	6	.353
occupation	160.994	21.017	12	.000
health condition	176.685	36.708	6	.000

Figure 5 likelihood ratio test

1) From the survey questionnaire, 75.4% of people with university or higher education among those who often use smart medical APP, while 0% of people with elementary school education. Although from the results education has a significant effect on the using frequency, from the likelihood ratio test, it can be obtained that the significance of gender and education are greater than 0.05, so gender and education are only considered as influencing factors, but not significant.

2) In terms of age, occupation and health condition, all three significant differences are less than 0.05, and it is considered that age, occupation and health condition have a significant effect on the using frequency. From the analysis of data, it shows that young people and adults between the ages of 18-30 and 31-45 use smart medical APP more frequently, which is related to their lifestyle and acceptance of new things. On the contrary, 58.6% of the elderly have never used the smart medical app due to their limited ability to accept new things.

3.3 Economic and medical level

3.3.1 Objects and methods

By finding data on GDP, the number of smart hospitals assessed at level 3 and above, the number of smart patents, the number of Grade A tertiary hospitals, and the realization of regionalization of Internet hospitals in 34 provinces in China (Taiwan, Hong Kong, and Macau were removed for data collection reasons) in 2021, the impact of the above factors in each province was analyzed comprehensively. Data were obtained from Wisdom Research Consulting, the National Health Commission, and the work reports of provincial governments nationwide, and binary logistic regression analysis was conducted using SPSS 27.0.

3.3.2 Establishment of model

For the results of the analysis of the market size of the smart healthcare industry, the market size are only divided into exceeding the mean and not exceeding the mean. Whether the size of the smart medical market exceeds the average is the dependent variable Y. The definition of Y=0 means not exceeded and Y=1 means exceeded the mean value.

P indicates the probability that exceeds the market size. Since the dependent variable Y is a discrete variable, it is not possible to use a linear probability logistic model for regression analysis, but a nonlinear logistic model. Incorporating all variables to be considered, a binary logit model shaped as follows.

$$\text{logit}(Y)=\log(p/(1-p))=\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4+\beta_5 X_5 \quad (2)$$

In the above equation, Xi(i=1,2,3,4,5) is the independent variable, which is the influencing factor to measure whether the size of smart medical market exceeds the mean value, βi is the corresponding coefficient. The corresponding meanings of the independent variables are shown in Fig 6.

influencing factor	range of value	content of assignment
Whether the market size of smart medical industry exceed the average value (Y) in 2021	0-1	0=no, 1=yes
GDP level in 2021 Whether exceeds the average value	0-1	0=no, 1=yes
In 2021, smart hospitals assessed whether the number of hospitals passing Grade 3 and above exceeded the average (X2)	0-1	0=no, 1=yes
Whether the number of smart patents exceed the average in 2021 (X3)	0-1	0=no, 1=yes
Is the hospital platform regionalized (X4)	0-1	0=no, 1=yes
Whether the number of top three hospitals exceed the average (X5) in 2021	0-1	0=no, 1=yes

Figure 6 independent variables

3.3.3 Results and Analysis

From the results of the model fitting information, it can be obtained that the selected independent variables are significantly different from the dependent variable with significance <0.05. For the initially established regression equation, according to the probability values by the great likelihood, the significance level was given as 0.05. After several rounds of screening and excluding the insignificant variables, the regression results obtained are shown in the figure.

	model fitting condition	likelihood ratio test		
model	-2 log likelihood	chi-square	freedom	significance
Intercept only	31.571			
finally	12.069	19.502	4	.001

Figure 7 Model fitting information

likelihood ratio test			
effect	chi-square	degree of freedom	significance
Whether the hospital platform regional	3.973	1	0.046
Number of smart patents in 2021	12.484	1	0.000

Figure 8 likelihood ratio test

(1) From the GDP of each province, Guangdong Province has the highest GDP development level in 2021, followed by Jiangsu Province, Shandong Province and Zhejiang Province. Even though the economic level is developed, it is not significant in the statistical results. Therefore, it is only considered that the GDP development level of each province is an influencing factor on the development of smart medical care, but it is not significant.

(2) In terms of the level of regionalization of Internet hospitals, only 10 provinces have achieved regionalization of Internet hospitals, and from the statistical results, it is considered that the level of regionalization of Internet hospital platforms has a significant impact on the development of smart medicine.

(3) In terms of the number of smart patents, according to the statistics, 20 cities in China have applied for patents. Among all the provinces that have applied for patents, the number of patents applied for in Guangdong Province has reached 490. From the statistical results, it is considered that the number of smart patents has a significant impact on the development of smart healthcare.

(4) In terms of the number of smart hospitals assessed at level 3 and above, only 10 hospitals passed the assessment at level 3 and above, which was not statistically significant. Therefore, it is only considered as an influencing factor, but it is not significant.

(5) The number of Grade A tertiary hospitals is one of the important factors in measuring the development of local medical level, but it is not statistically significant in the results. Therefore, the number of tertiary hospitals is only considered as an influencing factor, but not significant.

4. Measures

From the statistical analysis, we can see that the concept of smart medical is popular among teenagers and middle-aged people in urban life, and many elderly people who are in need of a lot of medical resources do not know what smart medical is and what it does; from the development level of each province, technology is still a key factor limiting the development of smart medical, and the existing functions of online medical still lag behind the actual needs of users; in the face of the normalization of epidemic prevention and control, the demand for online medical care is increasing, and the infrastructure of the smart medical system still needs to be improved. In order to promote the further development of smart medicine, this paper puts forward the following suggestions.

1) Strengthen the promotion and popularity and break the condition restrictions

The government, society and the hospital itself should strengthen the use and promotion of the smart medical system by setting up special publicity points and organizing volunteers for door-to-door publicity to increase public recognition and demonstrate the accuracy and convenience of the online medical platform as much as possible. In addition, it is important to expand the scope of use of the smart medical system and break geographical restrictions. In addition to sinking into townships, eyes can also be placed on the refined market of towns and cities. As Professor Engel, an American psychiatrist, proposed the bio-psycho-social medicine model, which advocates that effective treatment of patients must pay full attention to their physical, psychological and social needs [3].

2) Improve the ability of technological innovation to realize the regionalization of Internet hospitals

The first priority for the sustainable and healthy development of WITMED is still to improve the ability of scientific and technological innovation. We should make full use of the Internet's characteristics of "connection, intelligence, experience and cross-border" [4], and strengthen the connection with cloud computing, IOT, and other technologies. Through the implementation of the "Internet + medical" model, relying on the construction of medical associations, breaking the situation of "data silos", so that patients in medical associations, medical communities within the effective triage [5], to achieve the regionalization of Internet hospitals. At the same time, constructing a complete Internet medical platform system to reduce the pressure of the network platform during peak periods, to achieve targeted treatment of residents.

3) Strengthen the government’s leadership capacity and improve the infrastructure of smart healthcare under epidemics

In the general environment of epidemic, medical resources are highly strained and some residents will seek online medical platform consultation in order to avoid the risk of cross-infection in hospitals. To ensure that online consultation is formalized, streamlined, and rationalized, the government and hospitals should build a complete and simple appointment process, improve remote access and online medicine ordering services, and establish and improve the legal system of information security and privacy, administrative supervision system, and medical technology system as soon as possible [6]. Especially with the continuous growth of digital economy industry, it is important to focus on understanding and helping the development of the smart medical industry, and to recognize the significant help that the online medical industry can bring in an epidemic situation, so that individuals, companies and society can collaborate more effectively.

5. Conclusion

This paper uses logistic regression analysis based on SPSS 27.0 to conduct a comprehensive analysis of factors affecting the development environment, personal traits, and economic and medical level of smart medical services. It can be found that users have a certain understanding of smart medical and its further development is of great concern in the future; age, occupation and health condition have a significant effect on the frequency of using smart medical APP; whether the Internet hospitals are regionalized and the number of smart patents can significantly influence the development of smart medical care. Analyzing the influencing factors

of smart medical care in the context of big data not only helps to target the influencing factors for targeted propaganda and accurate positioning of users, but also can further clarify the development direction of the technology on which Internet medical care relies.

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