

Application and Analysis of National Traditional Chinese Medicine Hospital staff forecast

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Abstract. Objective: To explore the methods for modeling and predicting the personnel of Chinese medicine hospitals in China, and provide reference for the staffing of Chinese medicine hospitals. Methods: Based on *the statistics of Chinese medicine* from 2002 to 2017 on the number of employees in Chinese medicine hospitals nationwide, three models including regression, ARIMA and exponential smoothing were discussed, and the intraclass correlation co-efficient (ICC) with the largest value was selected as the final optimal model. Result: The final optimal prediction model is expressed as: ARIMA (0, 2, 2). R^2 is 0.990, and the two-way mixed effect model between the predicted value and the observed value has an absolute uniform ICC value of 0.997. Conclusion: The model data has a good fitting degree with the actual data. The selected prediction model is feasible for the prediction of the personnel of the national TCM hospitals in China, and it is of great significance for the staffing reference.

1. Introduction

Health human resources are an important part of a national or regional health care system, and are the most dynamic factor in health care, and one of the important prerequisites for improving the quality of health services [1]. The human resources of Chinese medicine hospitals are an important part of health human resources. With the emphasis on Chinese medicine and the growing social needs, the human resources of Chinese medicine hospitals need to be predicted. The purpose of this study is to determine the optimal model by exploring a variety of forecasting and modeling methods based on the data of the "National Statistical Extract of Traditional Chinese Medicine" from 2002 to 2017, so as to provide a reference for the staffing of traditional Chinese medicine hospitals.

2. Source and method

2.1 Research object

The data comes from the Class A-Chinese medicine resources in the National Traditional Chinese Medicine Statistics Extract. This paper selects the number of employees, the number of health technicians, the number of other technicians, the number of management personnel, and the skilled workers of the national TCM hospitals from 2002 to 2017. Using Excel 2016 for descriptive analysis (Figure 1), on-the-job employees include health technicians, other technicians, management personnel, and skilled workers. Among them, the ordinate represents the number of people and the abscissa represents the year. The number of employees in the national TCM hospitals has steadily increased since 2006, and exceeded 1 million in 2016. The time series of the number of employees in the national TCM hospitals in the whole country shows a growing trend and has a strong stability.

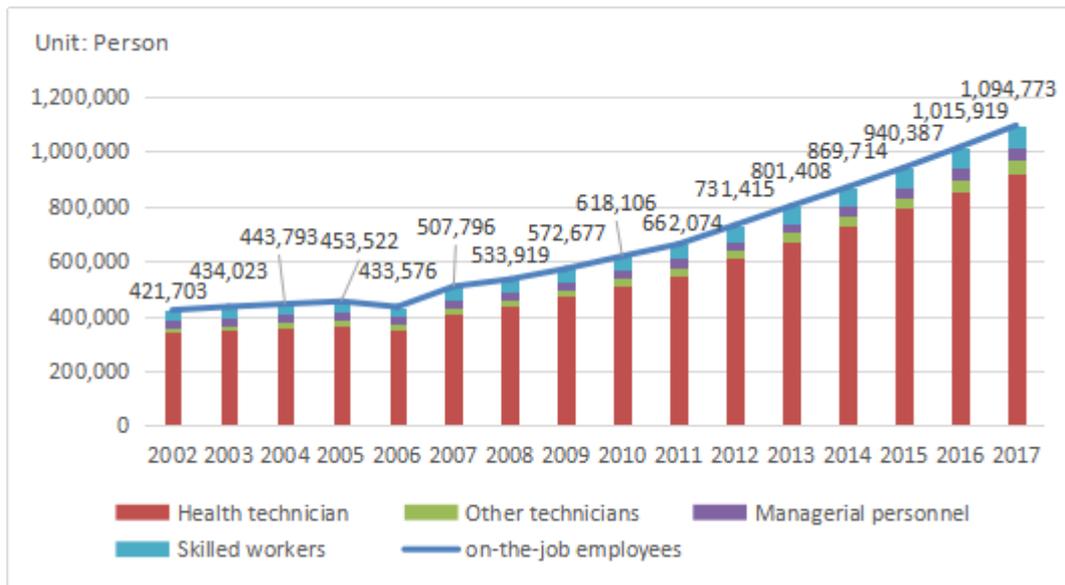


Fig. 1. Number of employees in the national TCM hospitals

2.2 Research methods

Spearman correlation analysis was used to analyze the correlation between variables, and to explore the curve fitting relationship (primary, secondary or tertiary curve); regression analysis and establishment of prediction model for the number of employees in the national TCM hospitals and the number of managers of the national TCM hospitals; The time series analysis method is used to explore the index smoothing model and ARIMA model of the number of employees in the traditional Chinese medicine hospitals. The corresponding coefficient (R^2) and Bayesian information criterion (BIC) indicators are used to determine the corresponding category optimal model; the optimal regression model is applied respectively. The ARIMA model and the exponential smoothing model predict the number of employees in the national TCM hospitals. The largest intraclass correlation co-efficient (ICC) is the final optimal model. Data were analyzed in SPSS 19.0 , and the difference was statistically significant with a two-sided test of $P < 0.05$.

3. Result

3.1 Related factor analysis

The correlation between the number of employees in the national TCM hospitals and the number of managers in the national TCM hospitals was analyzed by Spearman correlation analysis. The results showed that there was a significant correlation between the two variables. The correlation coefficient r is 0.938, which is close to 1, indicating a strong linear dependence between the number of employees in the national TCM hospitals and the number of Chinese TCM managers.

According to the software calculation, the R^2 of the number of on-the-job employees in the national TCM hospitals and the number of national TCM management personnel in the first, second and third time curves are 0.951, 0.968, 0.969, respectively. After comprehensive consideration, in the three curve fittings, although the cubic curve is about 0.01 higher than the quadratic curve in terms of R^2 , but in the curve complexity, the quadratic curve is calculated by the order of magnitude, and finally the quadratic curve is selected for the relationship.(See Figure 2)



Fig. 2. Relationship fit diagram

3.2 Curve regression analysis and prediction

Taking the number of employees in the national TCM hospitals as the dependent variable, the number of managers of TCM hospitals in China is the independent variable, and the regression model coefficient table is obtained. According to the regression coefficient of the model (B), the regression equation is obtained: the number of employees in the national TCM hospitals = $-0.001 * \text{National TCM hospital management personnel number}^2 + 99.234 * \text{National TCM hospital management personnel number} - 1664960.758$. The number of managers of the national TCM hospitals in 2017 was substituted into the equation for prediction, and the predicted number of employees in the national TCM hospitals was 1109850.0331. Its 95% confidence interval is [984911.0148, 1234789.0515].

3.3 ARIMA model and prediction

The time series model is a mathematical model based on the continuity of time as a theoretical basis [2]. Time series analysis methods can be divided into two categories, one of which is based on stochastic theory, and the ARIMA model belongs to this category. Time series analysis was used to explore the ARIMA model of the number of employees in the traditional Chinese medicine hospitals. After processing, the time series of the data was processed, and then the steps of smoothing, model identification, parameter estimation and detection were combined, and the expert modeler was combined to maximize the R^2 value. The minimum BIC value is the standard judgment optimal model. Finally, the non-seasonal ARIMA (0, 2, 2) is considered as the optimal model, and its R^2 value and BIC value are 0.990 and 21.016, respectively. Applying the model to predict, the number of on-the-job employees in the national TCM hospitals in 2017 was 1123361.3109, and the 95% confidence interval was [1028744.3713, 1224802.2473]. The model prediction chart is shown in Figure 3.

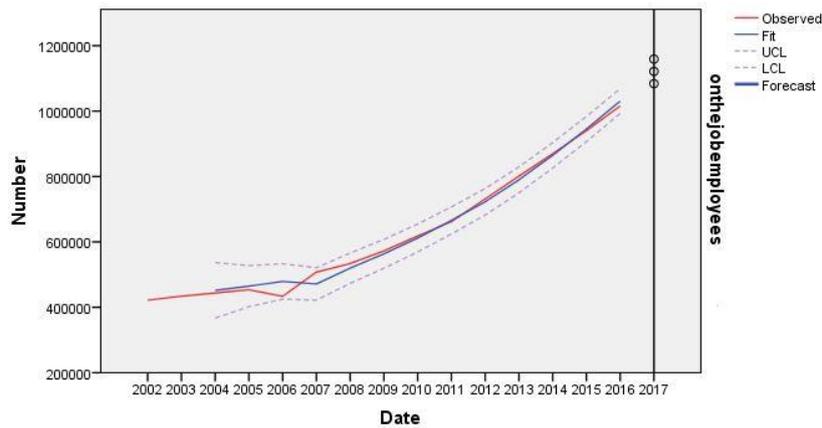


Fig. 3. ARIMA model prediction chart

3.4 Exponential smoothing model and prediction

The exponential smoothing prediction method is a trend extrapolation prediction model, and is another type of time series analysis method. In general, it is to use the accumulated statistical data over the years to predict the future development direction. Using time series analysis to explore the simple model of the number of employees in the traditional Chinese medicine hospitals, Holt linear trend model and other exponential smoothing models, the optimal model of the optimal ARIMA model is selected to judge the optimal model. Finally, the Brown linear trend model is considered to be the best. The R^2 value and the BIC value were 0.989 and 20.280, respectively. Applying the model to predict, the number of employees in the national TCM hospitals in 2017 was 108,7181.4130, and the 95% confidence interval was [1037650.0560, 1136712.7701].

3.5 Verification model

The intra-group correlation coefficient ICC is often used to evaluate the reliability or consistency of measurements obtained by different methods or assessors of the same quantity [3]. There are different ICC statistics in SPSS. This paper calculates the absolute uniform ICC for a single measurement of the two-way mixed effect model. This study explored the relative optimal models of the three types of models, and applied them to predict the number of on-the-job employees in the national TCM hospitals from 2002 to 2017, and to make the two-way mixed effect model and the actual value absolutely consistent. The ICC values of the sex analysis, curve regression, ARIMA model and exponential smoothing model were 0.985, 0.997, and 0.995, respectively. Among them, the ARIMA model is the highest, and the consistency between the predicted value and the actual value can be considered significant, suggesting that it can be used as the optimal model to accurately predict the number of employees in the national TCM hospitals.

Table 1. Comparison of actual and fitted values of ARIMA (0, 2, 2) model

Year	Observation	Fitted value	Value error	Relative error	LCL	UCL
2011	662074	664697.3505	2623.3505	0.40%	623906	705488
2012	731415	720606.7957	-10808.2043	-1.48%	680716	760498
2013	801408	787127.526	-14280.4740	-1.78%	747975	826280
2014	869714	861017.3222	-8696.6778	-1.00%	822483	899551
2015	940387	939776.6459	-610.3541	-0.06%	901769	977784
2016	1015919	1022917.484	6998.4837	0.69%	985365	1060470
2017	1094773	1110714.774	15941.7742	1.46%	1073559	1147871
2018	-	1203053.716	-	-	1166247	1239860
2019	-	1304717.492	-	-	1267587	1341848
2020	-	1412873.529	-	-	1375352	1450395

4. Discussion

According to the model prediction, the number of employees in the national TCM hospitals will continue to grow. According to the Ministry of Health's "General Hospital Organizational Principles (Trial Draft)", the target annual health human resources will be allocated: administrative management and work and work personnel account for 30% of the total compilation, of which administrative management personnel account for 10% of the total compilation; health technology Personnel accounted for 70% of the total editors, of which other health technicians accounted for 8%. In 2017, the number of employees in Chinese medicine hospitals in China was 1,094,773, including 921,752 health technicians, 45,426 other technicians, 46,924 managers, and 80,671 workers and technicians. According to the above ratio, the situation of various types of staff in Chinese medicine hospitals in 2017 was calculated: health technicians accounted for 84.20% of the number of employees on the job, other technicians accounted for 4.15% of the number of employees on the job, and administrative and work personnel accounted for 11.65% of the number of employees on the job, of which administrative personnel accounted for only 4.29% of the number of employees on the job. Compared with the expected configuration of general hospitals, the proportion of health technicians is high, and the proportion of administrative staff is far from the target ratio. Therefore, through the data of this study, the health and family planning department should do a good job in the allocation of health human resources in light of local conditions, strengthen the training of high-level health technical personnel, and appropriately increase the position of management personnel in the future allocation of human resources, and improve the management level of hospitals.

Acknowledgement

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