



Analysis and Prediction of Factors Influencing Residents' Willingness to Sign up for “Family Doctors” Under Micro-family Vision

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Abstract. In order to solve the problem of predicting and analyzing the factors influencing residents' willingness to enroll in "family doctors", this paper proposes an analysis method using BP neural network machine learning, taking into account multiple factors under the micro family vision. Firstly, we analyze five types of variables that characterize the main members of a resident's family, namely, occupational factors, head of household factors, economic factors, political factors, and health factors, and establish a prediction model using satisfaction with signing the contract as the criterion. Secondly, the BP neural network prediction model was constructed based on 568 sets of survey data, and the prediction was carried out in city A and city B, respectively. Finally, the coupling relationship between the factors influencing residents' willingness to contract with "family doctors" was analyzed and discussed. As a result, the model shows good fitting characteristics, confirms its applicability and practicality, and brings new ideas and methods to the study of residents' willingness to sign up for "family doctors".

Keywords: Micro-family vision, Family doctor, Signing service contract willingness, Influencing factors, Analysis and prediction.

1 Introduction

The origin of the family doctor system can be traced back to the 19th century in the United Kingdom. Family doctors, known as General Practitioners (GP, General Practitioner) in the United Kingdom, provide daily consultation and treatment services to community residents. Because they are familiar with the health status of each family member, they are able to detect potential illnesses at an early stage and manage chronic diseases on an on-going basis, and refer patients to specialized hospitals for treatment through a referral process when necessary, the advantages of this model have contributed to it becoming an important model of universal healthcare services [1]. Family doctors mainly provide basic medical services, including health management, chronic disease management, vaccination, and diagnosis and treatment of common and multiple diseases. Through the establishment of family doctor contracting service, patients can

establish a long-term doctor-patient relationship with their doctors. China's "family doctor" system has gone through many stages of development, and in recent years, with the advancement of China's healthcare reform, the role and function of the family doctor has been gradually emphasized and strengthened. The Chinese government has emphasized the importance of family doctors in the healthcare reform and introduced a series of policies to promote the construction of the family doctor system. Especially in the Outline of Healthy China 2030 Plan, it is clearly stated that the capacity of family doctor services should be enhanced. Family doctor contracting service is an important part of the family doctor system. Patients can choose a family doctor and sign a service agreement, while the doctor is responsible for providing the contracted patients with services such as regular health check-ups, health counseling and disease management. The family doctor team usually consists of general practitioners, nurses and other medical staff, and primary healthcare institutions (such as community health service centers and township health centers) are the main venues for family doctor services. China's "family doctor" system has received policy support and has developed rapidly. However, in practice, there is a problem of "name but no reality" of the family doctor contracting service policy [2] [3]. In order to fulfill the required signing rate, some places keep introducing preferential policies to attract family doctors and residents to sign, although the amount of signing reaches the standard, the follow-up service cannot keep up with the phenomenon of "being signed", "signing on behalf of the signing", "false signing", and so on. The phenomena of "being signed", "signing on behalf of", "false signing" and so on are emerging [4] [5]. Public awareness and acceptance of "family doctor" still needs to be improved. Residents' willingness to sign a contract with "family doctors" varies, and surveys show that some patients are used to going to hospitals directly, and their acceptance of the service model of family doctors is different. According to the statistics of this study, the main factors affecting the willingness of residents to sign a contract with a family doctor include several factors related to the characteristics of micro-families, such as occupational factors, head of household factors, economic factors, policy factors, and health factor characteristics.

According to the existing studies, there are the following shortcomings in the research on the mechanism of "family doctors": (1) the impact of the micro-family perspective on the willingness of "family doctors" to sign a contract is not prominent; (2) the characterization of the family situation of different residents has been neglected. In this study, we constructed quantitative indicators for the characterization of microfamily characteristics, including occupational factors, head of household factors, economic factors, policy factors, and health factors, and analyzed the data on the main characteristics of micro-family, and then predicted the residents' willingness to sign up for a "family doctor" contract by using an artificial neural network method. Finally, based on the prediction results, we give recommendations on the policy mechanism for the fulfillment of the "family doctor" contract. The innovations of this paper are: analyzing the status of residents' family doctor contract compliance and the heterogeneity of the characteristics of families with different contract willingness; studying the relationship between family factors and family doctor contract compliance under the vision of the family; and trying to discover and grasp these patterns, and suggesting ways to improve the performance of family doctor contract compliance. The study attempts to discover

and grasp these patterns, and proposes to improve the coverage rate and utilization rate of “family doctors” signing up.

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2 Analysis of Influencing Factors on Willingness to Sign and Perform

2.1 Definition and Value Range of Influencing Factor Variables

This study analyzes five types of variables, namely, occupational factors, head of household factors, economic factors, policy factors, and health factors, which are included in the scope of the study from the micro-family perspective. The occupational factors of the main members of the household include “the proportion of household members with stable monthly income”; the head of household factors include “having the right to control the financial income and expenditures of the household, and being the main provider of household income”; the economic factors include “per capita disposable income”; and the economic factors include “the proportion of household members with stable monthly income”. per capita disposable income”; policy factors include “knowledge of and satisfaction with existing policies”; and health factors include “family members in need of special attention and members with major and chronic diseases”. The details are shown in Table 1, and the criteria for determining the degree of satisfaction with the contract as a criterion are set at three output values: very satisfied, generally satisfied, and very dissatisfied.

Table 1. Characteristics and factors of members in resident families from a micro family perspective.

Dimension	Variable	Value Range
Occupational factors	Proportion of household members with monthly income from stable employment	0%-100%
Head of household factor	1-Possibility that the head of the household has financial control over the household	0-100
	2-Proportion of weights is the main provider of economic income	0-100
Economic factors	Disposable income per capita of the household	Specific values
Policy factors	1-Mastery of current policies	0-100
	2-Score satisfaction with current policies	0-100
Health Factors	Household members in need of special attention	Specific values

2.2 Analysis of Influencing Factors

In the study, a survey was conducted on the willingness of residents in cities A and B to sign up for the “family doctor” program, and a sample of 568 households was organized. As described in section 2.1, the satisfaction with the contract was analyzed from the microfamily characteristic factors, as shown in Fig. 1, in which the satisfaction with the contract was classified into three conditions: very satisfied, generally satisfied, and very dissatisfied.

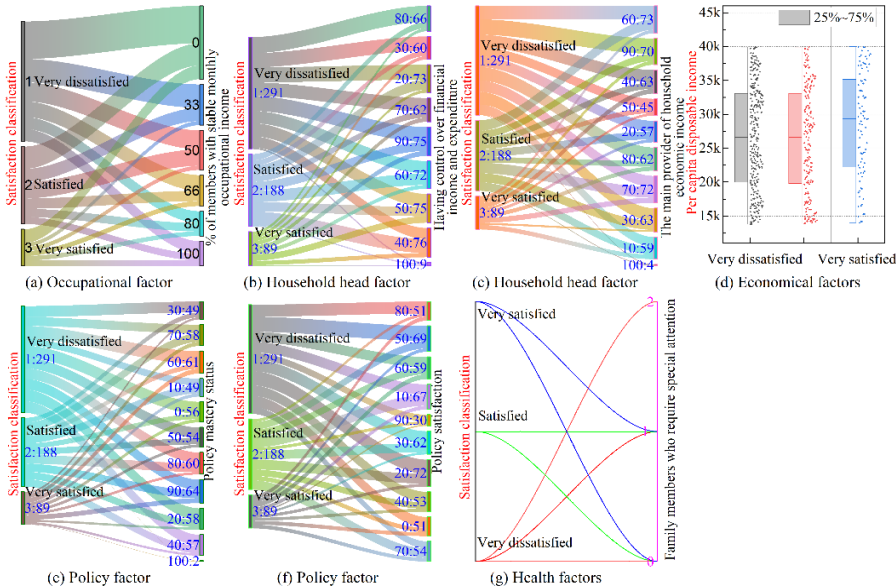


Fig. 1. Analysis of family characteristics factors and contract performance satisfaction

According to the analysis of the survey data, the proportion of members with monthly stable occupational income is measured from the consideration of occupational factors of family members, as shown in Fig. 1(a), the lower the proportion of members without monthly stable occupational income is, the lower the satisfaction with the willingness to sign up for the “family doctor” contract is, and the satisfaction with the willingness to sign up for the “family doctor” contract increases with the proportion of members with monthly stable occupational income rising; as shown in Fig. 1(b)(c), the head of the household has the right to sign up for the “family doctor” contract. However, as the proportion of household members with stable monthly income increases, the satisfaction with the willingness to sign up for “family doctor” increases significantly; as shown in Fig. 1(b)(c), the intensity of the head of the household's control over the household's financial income and expenditure, as well as whether or not the head of the household is the main provider of the household's financial income, have a significant impact on the willingness of “family doctor” to sign up for “family doctor”. “As shown in Fig. 1(d), the per capita disposable income of the family members has a direct impact on the satisfaction of “family doctors” in terms of the economic factors of the family, and it can be seen that the median per capita disposable income of the families

that are very satisfied reaches 29K, which is significantly higher than that of the families that are satisfied and dissatisfied. The median per capita disposable income of very satisfied families reaches 29K, which is significantly higher than that of satisfied and dissatisfied families which reaches 26K; at the same time, as seen in Fig. 1(e)(f), considering the overall understanding of families of the current policy and their satisfaction with the current policy, the two indexes of the two factors are not optimistic, which shows that the number of dissatisfied families is larger than the number of satisfied families, and the number of satisfied families is larger than the number of very satisfied families; Fig. 1(g) takes the family members who need special attention such as the handicapped people, the major diseases, and the number of members with chronic diseases as an analyzing factor, Fig. 1(g) takes the number of family members who need special attention, such as the disabled, major diseases and chronic diseases, as an analyzing factor, and shows two typical situations, i.e., the more members in the family who need special attention, the lower the satisfaction with the willingness to sign up for “family doctors”, and the more satisfied families are with the willingness to sign up for “family doctors”, the more satisfied families are with the willingness to sign up for “family doctors”, the less satisfied families are. Families that are very satisfied with their willingness to sign a contract with the “family doctor” have fewer or no members in need of special attention.

3 Prediction Models

3.1 Intelligent Prediction Methods and Artificial Neural Networks

According to the survey data of this study, the data of residents' willingness to sign up for “family doctor” is characterized by small sample and irregularity. The use of machine learning and intelligent prediction methods is a good solution to deal with such problems. It is an algorithm that automatically analyzes the data to obtain the regularity and uses the regularity to predict the unknown data. Artificial neural network BP algorithm, also known as back-propagation neural network, is a supervised learning algorithm with strong self-adaptive, self-learning, nonlinear mapping ability, which can better solve the problem of less data, information-poor and uncertainty, and is not subject to the limitations of the nonlinear model [6]. It is widely used in various industries, including finance, healthcare, retail, manufacturing, etc., aiming to mine patterns from data for prediction and decision making.

In this study, we make full use of the advantages of the BP neural network prediction method to predict the residents' willingness to sign up for a “family doctor” contract, using the characteristics of the influencing factors of micro-residents' family members as the input variables, and satisfaction with the willingness to sign up for a contract as the output, and then make a prediction of the residents' willingness to sign up for a “family doctor” contract in different regions [7]. “The system model structure is shown in Fig. 2.

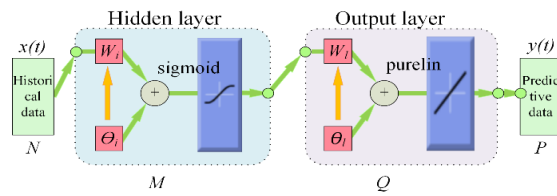


Fig. 2. BP neural network algorithm structure diagram

3.2 Predictive Modeling

As system inputs, household micro-characteristics factors include occupation: the proportion of members with stable monthly occupational income, head of household: the head of the household has financial control over the household and the intensity of the head as the main provider of economic income to the household, economic factors: per capita disposable income of the household, policy factors: including the state of the household's mastery of existing policies and its satisfaction with the existing policies, and health factors: the number of members of the household who need special attention. Health factors: the number of family members requiring special attention. Three categories of residents' satisfaction with the “family doctor” contract fulfillment was classified as very satisfied, generally satisfied, and very dissatisfied as the output of the system. An artificial BP neural network was constructed for prediction analysis, and the number of neurons in the input layer, hidden layer and output layer of the 2-layer neural network model was 7-5-1 respectively, and the specific model is shown in Fig. 3.

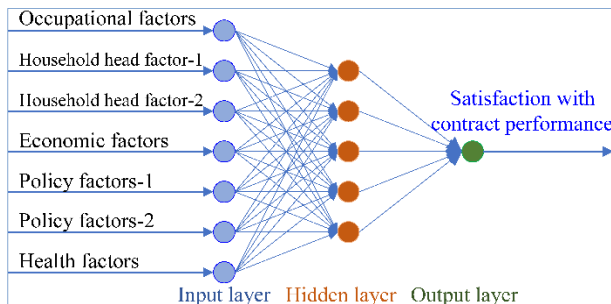


Fig. 3. BP model for predicting the satisfaction of residents' "family doctors" in signing and fulfilling contracts

4 Empirical Analysis

4.1 Data Sources

The research data of this paper mainly comes from the sample data totaling 568 groups, i.e., 568 families, obtained from the field survey and household interviews conducted by the research group on the residential families in part of City A and City B in Province

X. The sample data includes 308 groups, i.e., 260 groups of families. Among them, 308 groups in City A and 260 groups in City B. Table 2 below shows part of the survey data in City A and Table 3 shows part of the survey data in City B. The data from the two different areas were analyzed and projected individually and as a whole. The survey research shows that, on the whole, the data in this study are representative.

Table 2. Partial survey data for city A

No. of respondents	Proportion of household members with monthly income from stable employment	Possibility that the head of the household has financial control over the household	Proportion of weights is the main provider of economic income	Disposable income per capita of the household	Mastery of current policies	Score satisfaction with current policies	Household members in need of special attention	Satisfaction with contract fulfillment
1	66	60	10	27709	50	20	1	very satisfied
2	80	60	20	19677	90	40	0	satisfied
3	100	40	80	14936	90	30	0	satisfied
4	50	40	20	37264	70	30	0	satisfied
5	0	30	20	14566	10	50	0	satisfied
6	0	70	70	29667	60	30	1	very satisfied
7	80	50	60	21229	70	60	0	very satisfied
8	50	30	60	23936	30	80	0	very dissatisfied
9	33	90	90	23345	70	50	1	very dissatisfied
10	0	80	40	20223	30	60	1	very dissatisfied
11	50	80	50	24544	60	10	1	very dissatisfied
12	33	100	20	25292	10	90	0	very dissatisfied
13	0	90	40	36919	10	30	2	very dissatisfied
14	0	50	80	23490	30	20	0	very dissatisfied
15	66	60	20	33605	80	10	0	satisfied
16	0	40	70	16648	20	30	0	satisfied
17	0	90	60	21763	30	70	1	satisfied
18	100	50	80	14733	10	70	0	satisfied
19	50	90	40	35929	0	20	0	very dissatisfied
20	33	30	70	22517	60	0	0	very satisfied

Table 3. Partial survey data for city B

No. of respondents	Proportion of household members with monthly income from stable employment	Possibility that the head of the household has financial control over the household	Proportion of weights is the main provider of economic income	Disposable income per capita of the household	Mastery of current policies	Score satisfaction with current policies	Household members in need of special attention	Satisfaction with contract fulfillment
1	100	30	60	37298	10	0	0	satisfied
2	50	70	80	14613	90	50	0	satisfied
3	100	70	60	14402	80	10	1	very dissatisfied
4	0	50	80	31391	60	90	0	very dissatisfied
5	0	80	90	35815	80	30	0	very dissatisfied
6	50	90	70	33555	10	30	0	very satisfied
7	100	90	60	33439	70	70	0	very satisfied
8	0	80	10	38575	20	20	0	very dissatisfied
9	33	40	90	16677	90	10	1	very dissatisfied
10	80	50	50	21883	0	20	0	very dissatisfied
11	33	20	30	35641	40	50	1	satisfied
12	0	50	90	18314	30	20	0	satisfied
13	80	40	20	19871	70	60	0	satisfied
14	0	80	60	24435	60	0	0	very dissatisfied
15	80	80	80	32722	0	10	0	very satisfied
16	0	80	50	29631	80	10	0	satisfied
17	33	50	10	32879	40	30	0	satisfied
18	50	90	90	24359	40	20	1	satisfied
19	80	20	80	29379	70	0	0	very dissatisfied
20	66	20	70	37998	20	20	0	satisfied

4.2 Data Simulation

According to the sample data obtained from the survey, the model designed in section 3.2 is trained by BP network for prediction. The first 250 sets of data from city A are selected as training and the last 58 sets of data are used as testing for comparative analysis. Similarly, the first 200 sets of data of city B are selected as training and the last 60 sets of data are used as testing for comparative analysis. the prediction results and deviations of city A are shown in Fig. 4, and the prediction results and deviations of city B are shown in Fig. 5.

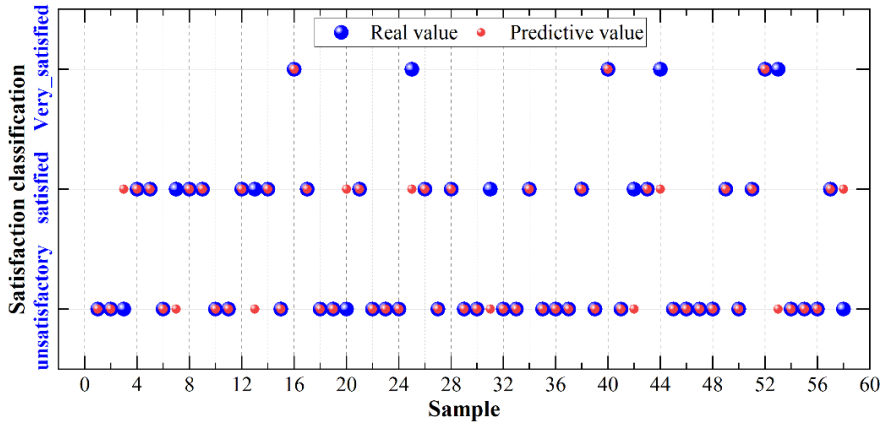


Fig. 4. Prediction results and deviation of city A

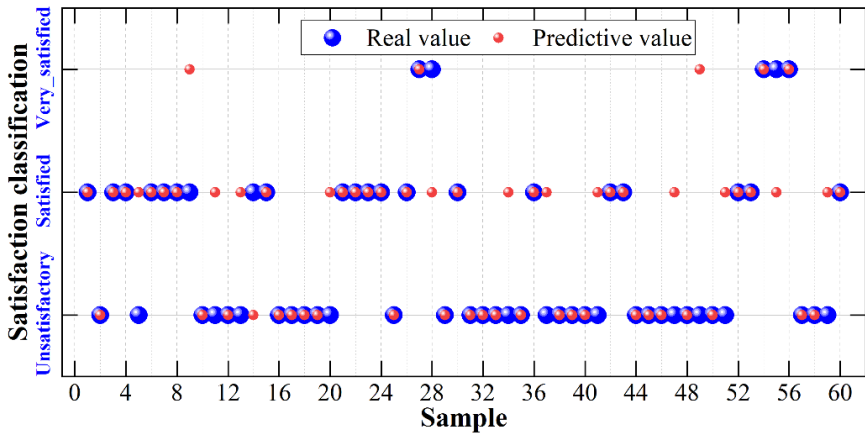


Fig. 5. Prediction Results and Deviation of City B

For further exploration, it is possible to categorize multiple cities in Province X according to the micro-family characteristics of cities A and B, and to predict the future performance of residents of each city in signing up for a “family doctor” through calculations.

4.3 Discussion

From the perspective of micro-family vision, high-quality contracting performance of family doctors is an important policy advantage for realizing universal health benefits for residents, and micro-family characteristic factors are the decisive reference internal factors in the analysis of influencing residents' willingness to contract performance of "family doctors". However, there are various factors affecting the contract compliance behavior from the perspective of micro-family characteristics factors, and some of the factors also form a game and coupling between them, influencing and relying on each other. The coupling between multiple factors influencing an outcome is a complex and important concept that is widely used especially in the fields of scientific research, engineering, social science and economics.

From the level of social public management and welfare protection, high-quality family doctor contract fulfillment also depends on the support of medical conditions at the national level. China's medical resources are unevenly distributed, and the level of medical supply has not yet fully met the people's health needs [8]. According to the National Data of the National Bureau of Statistics, the number of health technicians per 10,000 people, the number of practicing physicians per 10,000 people, and the number of registered nurses per 10,000 people have shown an overall growth, and the number of primary health care institutions has an obvious advantage over the number of hospitals, which is a clear advantage for the promotion of family doctor contracting performance. According to National Data survey data, China's medical resources are relatively tight, as shown in Fig. 6. In recent years, medical and healthcare resources have been improved and expanded, and high-quality medical resources have been expanded and sunk, so that residents can enjoy high-quality and efficient medical services at their doorsteps, and the realization of full coverage of family doctors' contracted fulfillment is precisely an effective practice of China's healthcare security system.

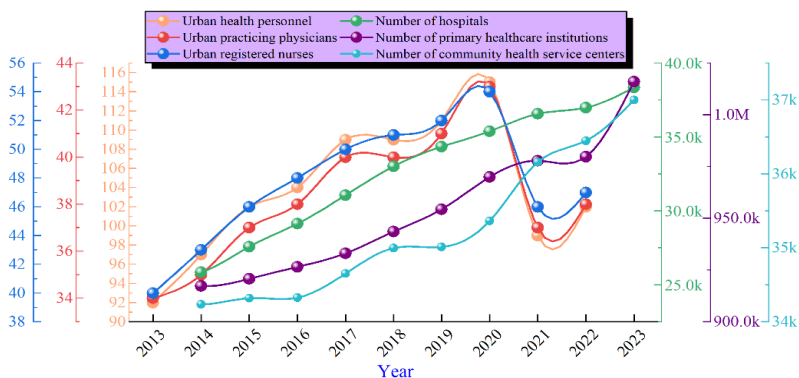


Fig. 6. Statistics on the development of medical resources in China

5 Conclusion

In order to analyze the influencing factors of residents' willingness to sign up for the "family doctor" under the micro vision of the family, this paper constructed quantitative

indexes for the analysis of the characteristics of the micro-family with the main members of the family as the core of the analysis of the occupational factors, head of household factors, economic factors, policy factors, and health factors, and used the BP algorithm of artificial neural network to model the correlation between the influencing factors and the satisfaction of signing up for the “family doctor”. The correlation between the influencing factors and contract compliance satisfaction was modeled. The system achieves higher prediction accuracy and shortens the training time of the model, and the model shows good fitting effect on non-time series data, which is widely applicable and practical in the field of prediction of residents' willingness to sign up for the “family doctor” contract. In the next step, the system dynamics model, network analysis and machine learning algorithms can be used to reveal the coupling relationship between multiple factors in the willingness to sign up for a “family doctor” contract. Through the in-depth study of multifactor coupling, the understanding of residents' willingness to sign up for family doctor services can be improved, and the accessibility and quality of family doctor services and residents' awareness of health management can be enhanced.

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