Multidimensional postpone-aging program for middle-aged and older females in China：An exploration and empirical study

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Abstract

Background

This study constructed multiple postpone-aging programme that include diet, lifestyle, health care products and beauty products in middle and old aged Chinese female, and verified results based on experimental evidence.

Methods

Multi stage cluster stratified sampling epidemiological survey was used to collect the PPSHAS aging measurement results and the information on diet type structure, behavior lifestyle, as well as the use of drugs, health products and beauty products of middle and old aged female in China. LR, DT and RF model was fitted and compared, and constructed postpone-aging programme. Aging markers such as content of IGF-1, content and activity of β-GAL and SOD in serum were detected to support the research.

Results

Aging measurements shows that 14.24% of subjects are significantly younger than chronological age, 45.58% are consistent, and 40.17% are significantly older. Through model performance comparison and verification, the RF model is relatively optimal, with precision of 82.64% and 80.62%, AUC of 0.894 and 0.892, accuracy rates of 82.80% and 89.78%, recall rates of 89.78% and 88.85%, F1 scores of 0.768 and 0.744, and Kappa index higher than the other two models in the test and validation set. Biological markers testing showed that SOD content and activity, IGF-1 content decrease with aging, while β-GAL activity increased (P<0.05). In the postpone-aging programme, the priority of variables from high to low is skin care product use, hobby duration, sleep time, lotion, eye cream, leafy vegetables, eggplant fruits, carbohydrates, water consumption, spices (importance 23.05 to 66.68).

Conclusion

The aging scores of middle and old aged Chinese female showed certain regular changes in chronological age and status age. The relatively optimized RF model constructed a three-dimensional postpone-aging programme, and LR and DT model also provided valuable information. The experimental evidence confirmed the ideality of the results.

Introduction

After years of efforts, China's elderly cause has made significant progress, such as realizing the national overall planning of basic endowment insurance, changing and improving institutional pension facilities and functions at a relatively fast speed, and preliminary creating an age-appropriate environment in the whole society. However, the aging trend of the Chinese population is still gradually accelerating and deepening, especially the major reality of the large scale, rapid growth and large internal differences of the elderly population, which has increased the complexity and arduousness of active response to population aging[1]In China, there are 137 million elderly female (≥ 60 years old)[2], and their life expectancy is longer than that of male, of which the proportion of elderly female (≥ 80 years old) is larger, leading to a longer unhealthy period, so female are more prominent in the physical[3–4], psychological[5] and social[6] fields of aging than male, with lower quality of life and more prone to aging.

The average life expectancy of Chinese female is higher than that of male, to a certain extent, it is related to their increased self-care awareness and tendency to take postpone-aging measures. Multiple studies in the field of aging have proved that female have significant differences with male in the structure of dietary type, lifestyle as well as use of drugs, health care products and beauty products[7–10]. However, the exploration of postpone-aging in Chinese women has been studied but not in-depth, and the results have not formed a definite program; and existing research often only explores the impact of single factors such as diet or behavior on women's aging, ignoring the combined effect between these factors. Hence, we

concentrated on multiple factors of aging, explored the possible ways of delaying aging in Chinese middle-aged and elderly women, and formed a programme in this study.

Material and Methods

The study obtained ethical clearance from the Second Affiliated Hospital of Nanchang University and all participations gave informed consent.

Study population

Some communities in five provinces in the eastern, western, southern, northern and central China were used as the research site, and the north and south China were divided according to the Qinling-Huaihe River line. Multi-stage stratified cluster sampling was carried out according to the four-level management mode of province-city-county-district, and the sampling work was implemented in the community. According to the pre-survey, the female age "obviously young" accounted for about 11.96% to 35.94%, the proposed median value of 23.95% was the positive probability (p), the bilateral test level α was 0.05, and the allowable error (δ) was 0.1p. Considering the non-compliance of participations, the original sample size was increased by 20%, finally the final sample size was 1500.

Inclusion criteria: Female (≥40-year-old) who actively participate in and cooperate with this research activity, and provide all information necessary for the research. Exclusion criteria: severe disease (tumor, autoimmune disease, vital organ failure) and disability, psychiatric abnormality; Noncompliance and unable to participate in the whole study. In order to improve the representativeness, the optimal allocation sampling was used in the sample allocation according to the composition of the population of different age groups.

Information Collection

The participants' aging degree was judged by the PPSHAS scale[11], which semi-quantitatively and quantitatively determined the state age through the percentile method (Supplementary Fig. 1) and the Growth model method (Supplementary Fig. 2). In addition, the following four categories of information were collected: basic demographic characteristics, dietary types and structures, lifestyle behaviors, and the use of health products and beauty products.

Statistical analyses

The software R (R Project for Statistical Computing, version 4.1.3, http://www.r-project.org/) was used for data analysis, statistical description and inference were carried out according to the characteristics of variables, and the collected huge multivariate variables were filtered based on univariate analysis, filter method and embedded method (α=0.05). The filtered variables fit the binary stepwise logistic regression model, decision tree model and random forest model, respectively. The performance of the three models was comprehensively evaluated by accuracy, specificity, Youden index, Kappa index, F1 score, AUC, and AUC difference between the two models, et al.

Experimental detection

In our research, the ELISA kit (96T, stored in 2-8 °C) of Jiangsu Meimian Industrial Co., Ltd was used to determine the IGF-1 content, β-GAL and SOD content and activity in human serum.

Quality control

Studies were conducted strictly according to pre-designed plan. Five provincial and municipal volunteers were selected, trained, assessed and identified from the undergraduate and master's students of Nanchang University as investigators, who undertook aging measurement and questionnaire survey, strictly assessed the investigators' operation skills and survey language, and the research leaders went to different survey sites for quality monitoring and guidance; Experimental

blood samples were collected on time, quota, and in a short period of time and tested timely to ensure the quality of serum samples.

Results

Demographic characteristics

A total of 1785 questionnaires were obtained in some communities in Jiangxi, Fujian, Shaanxi, Henan, Hebei and other provinces, of which 1720 were valid questionnaires, with an effective rate of 96.36%. The Qinling-Huaihe River line is divided into south(n=944) and north (n=776) China, the south is mainly composed of people aged 60~64 (18.43%), while the north is mainly composed of people aged 65~69 (17.91%), and the education level are both primary school and below. The occupational distribution shows that the proportion of workers in the south China is the highest (31.67%), but the proportion of married (77.33%) is lower than that in the north China (89.18%) (Supplementary Table 1). Female in the north China is significantly older, while in the south are younger (Supplementary Table 2).

The results of aging degree measurement showed that 14.24% of subjects were significantly younger than the chronological age, 45.58% were basically consistent, and 40.17% were significantly older. Among the age groups, the highest proportion of significantly younger people was the 75~79 years old group (20.17%), while the obvious elderly people was in the 40~45 years old group (48.87%) (Table 1).

Multi-component screening of postpone-aging factors

Based on the CHNS survey, we divided the diet types and structures into six categories: staple food, vegetarian dishes, meat dishes, between-meal nibbles, daily water intake, and seasoning. Convert the above dietary intake to weeks, and convert the intake of staple foods, vegetarian dishes, meat dishes, and snacks to calculate the intake of nutrients (energy, lipids, carbohydrates, dietary fiber, vitamins, minerals) (Supplementary Table 3 to 5). The life behavior of female was analyzed from three aspects: personal life characteristics; diet, wine and tea drinking habits; as well as sleep, exercise and work conditions (Supplementary Table 6 to 8). In addition, the use of western medicine, traditional Chinese medicine and health products was compared, and the different effects of health products were analyzed (Supplementary Table 9). Regarding beauty products, this study mainly analyzed the frequency of six products usage: sun cream, moisturizing water, milky lotion, eye cream, essence, and facial mask (Supplementary Table 10).

Machine learning model fitting and optimization

The simple random sampling method was used to randomly divide the training set and the test set (7:3), 55 variables were preliminary included after univariate analysis (P=0.01). In order to more accurately explore the influence of postpone-aging factors (X) on aging (Y), according to the requirements of high-purity and high-effect division metrics of machine learning models, 13 variables were eliminated base on filter method and: food water content, Ca, Fe, K, dietary fiber, fat, VE, VB, VC, VA, Number of skin-care products uses, dressing style, and staple food. Before the embedded method was used, the continuous variables were normalized, the categorical variables were treated as dumb variables, and then the Lasso classification regularization index screening and 10-fold cross-validation are performed (Supplementary Fig. 3, 4), and finally 24 variables are obtained (Supplementary Table 11).

Logistic Regression model

In this study, a stepwise LR model was constructed, and some non-statistically significant variables were removed from stepwise regression, the results showed that there were significant positive effects (OR□1) and negative effects (OR□1) of postpone-aging (Fig. 1).

Decision Tree model

In this study, the DT model was constructed and optimized based on the CP value (Supplementary Fig.5.). The generated tree is rooted in skin care products and grows 6 layers with a total of 11 terminal nodes (Fig. 2). Based on the results and professional knowledge, we constructed 11 sets of postpone-aging programme (contribution rate range 13.82% to 89.18%), of which 4, 5, 9 and 10 programme have an postpone-aging contribution rate of more than 60% (Table 2).

Random Forest model

Random forest is an integrated representation learning of decision tree, so we additionally build RF models and optimize them according to the relationship between model error and number of trees. In addition, according to the contribution of each variable to the average reduction of the Gini index, the importance of each variable was arranged from high to low, with the importance range from 8.07 to 66.68 (Fig. 3).

Machine learning model performance comparison

In this study, the 10-fold cross-validation was used to prevent overfitting of the constructed model. Total of 724 of the 1204 people in the training set were not aging, the RF model predicted the most accurately (n=650). Among the 516 people in the test set, 305 were not aging, and the DT model forecast the most accurately (n=272). The comprehensive performance calculation results of the model suggest that the evaluation indicators of the three models in the training set are better than the test set. In the training set, LR and RF models performed equally well, while RF performed best in the test set (Table 3). The ROC curve (Fig. 4) and AUC difference (Supplementary Table 12) results of the three models showed that the AUC values of LR and RF in the training set were higher than DT, and there was no difference between the two. But in the test set, RF>LR>DT.

Evidence of Aging Related Biological Markers on Aging Measurement Results

We randomly selected no less than 5% of the samples (n=99) from the survey subjects for the detection of five biological indicators: β-GAL and SOD content and activity, and IGF-1 content. There was no significant difference between the five biological indexes in different chronological age groups (P>0.05), and the correlation analysis showed that only the β-GAL content was less correlated with chronological age (r=0.263) (Table 4). However, the relationship between state age and biological markers was obviously different, and the results showed that except for the β-GAL content, the other four indicators had statistical differences in the three groups: SOD content, activity and IGF-1 content decreased with the deepening of aging, while the β-GAL activity showed that the overall increase increased with the deepening of aging. However, the relationship between state age and biological markers was obviously different, and the results showed that except for the β-GAL content, the other four indicators had statistical differences in the three groups (P<0.001): SOD content, activity and IGF-1 content decreased with the deepening of aging, while the β-GAL activity showed that the overall increase increased with the deepening of aging (Table 5).

Determination of the optimal postpone-aging programme for female

Combined with the above results, we think the RF model has the best comprehensive performance, so we construct an postpone-aging programme according to the top ten variables ranked according to the variable importance of the model: Chinese middle-aged and elderly female should pay heed to the long-term use of skin-care products, especially milky lotions and eye creams, invest more than 0.5 h in healthy hobbies every day, and sleep at 21~22 o'clock every night. The weekly intake of leafy vegetable should be 600 to 850 g, and the daily water intake should be 1200 to 1800 ml. It would be best that southern female can consume 200 to 350 g of solanaceous fruit vegetables per week, and not consume excessive carbohydrates, while consume spices appropriately. However, northern women should better consume more than 350 g of solanaceous fruit vegetables and more than 2600 g of carbohydrates per week, and reduce the intake of spices.

Discussion

With the continuous development of China's aging cause and geriatric medicine, as well as people's higher demand for elderly health, it is an inevitable trend to carry out new explorations to delay aging. This study mainly combines the special population of middle-aged and elderly women in China's aging society and the common factors of postpone-aging (daily diet, life behavior, beauty and health products) to actively explore, so as to reveal the relationship between these multiple factors and delay aging, thereby delaying their aging speed and reducing the occurrence and development of aging-related chronic diseases.

This study has been carried out continuously since 2018, mainly covering Jiangxi, Fujian, Shaanxi, Henan, Hebei and other provinces in China, with a relatively large research space and a relatively uniform north-south distribution of participants, which can reflect the objective reality of China to a certain extent. The aging degree results showed that the state age of the participants in the physical, psychological, social dimension and total aging dimension increased with the increase of chronological age, and the specific difference between the chronological age and the vital state age could be obtained, which to a certain extent proved that the connotation of the scale indicators could reflect the inherent aging change law of human life. For the sake of caution, we examined the content and activity of some recognized biological markers closely related to human aging [12–14], further demonstrating the link between state age and biological markers of aging and the delayed effect of anti-aging factors on aging.Considering that the human aging mechanism is complex and inextricably linked with many factors, we collected more relevant factors (177 items), and finally obtained 25 meaningful variables through univariate analysis and variable feature screening.

'Hunger breeds discontentment' is an important concept of Chinese dietary culture. The dietary results showed that the intake of leafy vegetables, solanaceous fruit vegetables, carbohydrates, daily water intake and spices are closely related to aging. Epidemiological studies and animal experiments have proved that leafy vegetables [15] are rich in vitamins and dietary fiber, tomatoes [16] are rich in lycopene and α-tocopherol, and peppers [17] are rich in VC and flavonoids, which can significantly reduce oxidative stress and endothelial cell aging, effectively prevent degenerative diseases and prolong life. Excessive carbohydrate intake can lead to obesity and overweight [18], and low-carb diets not only perform well in weight loss, insulin resistance, and blood glucose lipids [19], but also improve the prognosis, life quality of breast cancer patients [20]. After entering the old age, the total amount of water in the body is significantly lower than when it was young, and insufficient drinking water will cause metabolic disorders in multiple organ systems, and it is easy to make the skin lose elasticity, especially after physical exercise, timely replenishment of water is very necessary; In addition to plain boiled water, middle-aged and elderly women can drink dairy products to supplement calcium to delay muscle decline and osteoporosis [21–22]. Garlic, green onion, ginger contains allicin, gingerol, etc., can accelerate blood circulation, stimulate vasodilation, sweat and keep warm, so it is recommended that some cold northern women should take it appropriately, which may be conducive to anti-aging.

Lifestyle plays an important role in anti-aging and health care. Large epidemiological evidence suggests [23–24] that lack of hobbies is significantly associated with disorders such as depression, so it is recommended that women devote a certain amount of time each day to healthy hobbies and active social integration. Excessively long sedentary behavior is a major risk factor for dementia, cardiovascular disease, type 2 diabetes, cancer, and aging [25–26], and appropriate reduction of duration can increase the molecular oxidation capacity of skeletal muscle and improve signal transduction such as Ca++ [27]. We also paid enough attention to the role of emotional psychology and anti-aging in this survey, and the results showed that emotion in life, eating out, and importance of dressing were closely related to female psychology. For example, female who are enthusiastic about life tend to have higher satisfaction with family emotional life, actively participate in social activities such as eating out, attach more importance to dressing, lead to a lower stage age in psychological dimension and even aging. It is worth mentioning that healthy lifestyles can increase life expectancy of female by about 3.1 years, and the more healthier lifestyle factors (e.g., exercise, sleep, social interaction), the greater the positive effect on slowing cognitive decline [28].

Health care products and beauty products are favored by middle-aged and elderly women because of its unique effects. The subjects in this study mainly used health products with the effect of regulating endocrine, regulating sleep and moisturizing the intestines, and reflected that the main troubles of middle-aged and elderly women were endocrine disorders, sleep and excretion disorders. In the use of beauty products, the population of significantly younger and older showed the opposite tendency, especially population in a younger state will use multiple skin-care products, but the proportion of essence, facial mask and sunscreen users was lower. We suggest that beauty products may have anti-aging effects on female for three reasons: Firstly, anti-aging ingredients in moisturizing water, lotion, and essence that most women use such as Pro-Xylane, VC, fruit acid, ceramide, etc., can effectively improves the aging of facial skin, reduces the number and length of wrinkles, and maintains skin elasticity and tension; Secondly, skin care products that fewer female use have excellent performance, sunscreen can block ultraviolet rays and fight photoaging, facial mask promotes collagen and polysaccharide production, strengthens the skin barrier, eye cream specifically lightens wrinkles on the eyes, face and neck, and brightens the eye area;Lastly, with the development of Internet technology and the increase of network marketing, the psychological effect of skin care products in improving women's facial aging has been deepened, and users believe that after long-term maintenance, the skin can be gradually rejuvenated, and then persistently used, forming a positive closed cycle. Statistics of the China National Bureau of Statistics [29] indicates that, during the promotion period of the whole network in November 2022, the sales of beauty products including skin care products reached 56.2 billion yuan, which fully proves that women attach importance to beauty products, from the existing facts and trend analysis, women's strong demand for postpone-aging will bring a more vigorous development momentum to the beauty products industry, showing a broader market prospect.

This study also has some limitations, human aging and anti-aging research is a very complex topic, strictly speaking, macroscopic research, especially epidemiological research often stays in the induction and analysis of phenomena, so special caution should be exercised when drawing causal conclusions; In terms of research space, follow-up research should cover as many remote provinces as possible in China.

We hold the view that the model constructed is an auxiliary means of scheme construction, which does not mean the final result, and the factors that do not appear in the model do not need to be paid attention to. In fact, anti-aging is the result of the comprehensive action of multi-dimensional and diversified factors, and the obtained programme is refined in the screening of variables, as well as the fitting and optimization of machine learning models. In conclusion, this study provides a variety of feasible measures to postpone-aging for middle-aged and elderly female in China, and the variables that appear in the scheme are of high importance and require their attention. In general, taking more and more reasonable measures will help delay aging.

Abbreviations

AUC: Area Under Curve

β-GAL: β-galactosidase

CHNS: China Health and Nutrition Survey

CP: Complexity Parameter

ELISA: Enzyme-Linked Immuno Sorbent Assay

IGF-1: Insulin-like Growth Factors-1

LASSO: Least Absolute Shrinkage and Selection Operator

PPSHAS: Physiological-Psychological-Social three-dimensional Human Aging Scale

ROC: Receiver Operator Characteristic

SOD: Superoxide Dismutase

Declarations

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N/A

Authors' contributions

Z.LL analyzed and interpreted the data, and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Data availability

The datasets generated and/or analysed during the current study are not publicly available due protecting the privacy of participants but are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

According to the Declaration of Helsinki, the study obtained ethical clearance from the Second Affiliated Hospital of Nanchang University and all participants and their legal guardians will be informed about the study goals. Written informed consent will be obtained from all participants or their legal guardians prior to the study. All participant information and data will be stored securely and identified by a coded ID number only to maintain participants' confidentiality.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1 Standardized scores of aging degree and distribution in middle-aged and elderly female						
Chronological age	N	Physiological	Psychological	Social	Overall	State age
Significantly younger						
40~	21	17.41±1.48	11.36±1.63	4.36±0.75	33.13±1.87	28.18±5.79
50~	29	21.46±2.87	11.42±2.02	4.44±0.75	37.32±2.79	39.94±8.26
55~	25	22.99±2.56	10.68±1.58	4.68±0.86	38.35±2.98	42.66±8.26
60~	33	24.68±2.37	11.04±1.84	4.61±0.93	40.33±2.43	47.82±6.24
65~	54	27.80±2.59	11.84±2.06	4.72±0.82	44.36±2.19	57.41±5.03
70~	40	28.85±2.94	12.18±2.02	4.96±0.93	45.99±3.24	60.89±7.33
75~	24	30.43±3.93	10.83±1.72	4.81±0.75	46.08±5.13	60.71±11.71
80~	19	32.59±3.74	11.04±1.57	5.11±0.91	48.74±4.79	66.44±10.57
Total	245	26.05±5.02	11.42±1.91	4.71±0.86	42.18±5.46	51.63±13.34
F		114.134▲	2.525	2.137	86.317▲	84.891▲
P		<0.001	<0.001	<0.001	<0.001	<0.001
Basically consistent						
40~	92	20.92±2.63	13.81±2.02	4.84±0.65	39.57±2.20	45.95±5.66
50~	109	25.18±2.72	14.19±2.32	5.20±0.73	44.57±2.26	57.68±5.42
55~	117	26.76±2.81	13.77±2.26	5.66±3.42	46.07±2.22	61.01±5.32
60~	138	28.99±2.53	13.93±1.97	5.34±0.83	48.26±2.46	65.83±5.15
65~	139	31.24±2.78	14.48±2.35	5.66±0.87	51.39±2.12	72.15±4.16
70~	94	34.11±2.69	14.52±1.95	5.83±0.93	54.46±2.21	77.97±4.08
75~	45	36.78±2.49	14.28±1.75	6.16±1.18	57.21±2.04	82.91±3.62
80~	50	39.73±2.82	15.31±1.67	6.48±1.14	61.53±2.69	90.15±4.40
Total	784	29.33±5.69	14.20±2.14	5.55±1.59	49.06±6.18	66.75±12.7
F		389.3	5.156▲	8.155	715.026	656.26▲
P		<0.001	<0.001	<0.001	<0.001	<0.001
Significantly older						
40~	108	27.44±5.24	15.88±2.08	5.57±0.99	48.89±5.65	66.64±10.88
50~	72	30.73±4.06	16.70±1.79	5.96±1.16	53.39±4.39	75.75±7.75
55~	102	32.54±4.03	16.53±1.77	6.04±0.97	55.10±4.43	78.92±7.75
60~	106	34.71±3.30	16.66±1.96	6.16±0.85	57.52±3.65	83.32±6.21
65~	112	36.73±3.27	16.77±2.15	6.41±1.13	59.91±4.23	87.34±6.84
70~	97	39.41±3.01	17.34±2.11	7.05±1.36	63.80±4.44	93.64±6.72
75~	50	40.92±3.17	17.12±2.40	7.53±1.38	65.57±4.22	96.42±6.15

80~	44	44.94±2.77	18.24±2.29	8.61±1.95	71.80±4.37	105.51±5.91
Total	691	34.92±6.16	16.77±2.11	6.45±1.41	58.14±7.62	83.74±13.10
F		167.93▲	7.729	243.684▲	186.435	185.746▲
P		<0.001	<0.001	<0.001	<0.001	<0.001
Comparison of three groups						
F		290.224▲	653.264	254.99▲	652.23▲	649.36
P		<0.001	<0.001	<0.001	<0.001	<0.001

▲The Levene statistic results suggests that the variance is uneven, and the F distribution is approximated by Welch's method

Table 2 Postpone-aging protocol based on DT model

Protocol	Skin-care products	Eye cream	Duration of hobbies	Sleep time point	Region	Daily drinking water	Traditional Chinese medicine	Contribution rate	
								Not aging	Aging
1	Never use		0.5					13.82	86.18
2	Never use		≥0.5		North China			26.74	73.26
3	Never use		1~2		South China			40.00	60.00
4	Never use		0.5~1/ ≥2		South China			67.78	32.22
5	Use	Use						89.18	10.82
6	Use	Never use		Before 23:00		≥500		77.18	22.82
7	Use	Never use		Before 23:00		500		16.67	83.33
8	Use	Never use		After 23:00 /Uncertain			Use	22.73	77.27
9	Use	Never use		After 23:00 /Uncertain		500/ ≥1200	Never use	66.67	33.33
10	Use	Never use	≥2	After 23:00 /Uncertain		500~1200	Never use	85.71	14.29
11	Use	Never use	2	After 23:00 /Uncertain		500~1200	Never use	28.00	72.00

Table 3 Performance of three model in training set and test set						
Indicators	Training set			Test set		
	LR	DT	RF	LR	DT	RF
Accuracy (%)	82.48	79.57	82.64	75.58	75.97	80.62
Recall (%)	86.74	89.09	89.78	85.57	89.18	88.85
Specificity (%)	76.04	65.21	71.88	61.14	56.87	68.72
Youden index	0.631	0.543	0.650	0.562	0.497	0.629
Kappa index	0.632	0.560	0.630	0.480	0.481	0.590
Precision (%)	84.52	79.43	82.80	76.09	74.93	80.42
F1 score	0.776	0.718	0.768	0.672	0.659	0.744
AUC (95%*CI*)	0.892 (0.873,0.909)	0.820 (0.797,0.841)	0.894 (0.876,0.911)	0.840 (0.805,0.870)	0.793 (0.756,0.827)	0.892 (0.861,0.917)

Table 4 Analysis of serum biological indexes in female populations of different chronological ages						
chronological age	n	β-GAL content (pg/ml)	β-GAL activity (U/L)	SOD content (pg/ml)	SOD activity (U/L)	IGF-1 content (μg/L)
40~	23	222.07±19.54	47.41±4.86	184.03±24.13	753.44±68.31	185.21±24.34
50~	11	233.29±19.99	48.04±4.95	189.84±23.80	800.47±59.59	174.17±25.77
55~	11	223.17±24.47	49.38±4.43	191.11±24.76	774.81±82.65	187.80±21.79
60~	11	237.60±23.64	48.67±4.77	179.50±21.66	727.12±62.97	168.91±18.19
65~	11	223.73±11.25	48.19±4.80	196.94±21.90	778.66±70.74	181.79±20.79
70~	10	236.00±23.31	48.10±4.71	189.84±29.34	737.07±64.96	188.08±20.52
75~	11	239.58±25.16	49.37±5.48	196.34±14.75	768.35±79.16	182.36±20.10
80~	11	239.32±17.18	48.87±4.19	195.18±24.69	768.68±46.77	187.17±25.02
Total	99	230.62±21.39	48.38±4.68	189.59±23.35	762.61±68.66	182.27±22.58
F		1.793	0.306	0.855	1.345	1.078
P		0.098	0.950	0.545	0.239	0.384
r		0.263	0.105	0.175	0.005	0.015
P		0.009	0.300	0.083	0.958	0.886

Table 5 Analysis of serum biological indexes in female populations of different state ages

Biological indicator	Significantly younger (n=24)	Basically consistent (n=52)	Significantly older (n=23)	Overall comparison	
				F	*P*
β-GAL content (pg/ml)	238.59±24.84	229.73±25.51	227.50±16.76	4.461▲	0.107
β-GAL activity (U/L)	47.01±4.46	47.94±4.34	50.63±4.98	4.267	0.017
SOD content (pg/ml)	198.85±23.74	191.90±25.64	184.42±20.96	3.355	0.039
SOD activity (U/L)	793.58±68.64	754.10±68.00	751.38±63.84	3.196	0.045
IGF-1 content (μg/L)	193.32±21.71	181.14±24.12	177.91±20.96	3.983	0.022

Uneven variance by Levene's test, Kruskal Wallis H-test was used instead of one-way ANOVA, χ 2 as a statistic

Figures

Variable	ß	S.E.	Wald	OR(95%CI)	P
Region					
North China	0.9	0.2	19.11	2.48(1.65,3.74)	<0.001
Diet types and structures					
Solanaceous fruit vegetables(2)	−0.8	0.2	12.23	0.43(0.27,0.69)	<0.001
Solanaceous fruit vegetables(3)	−0.7	0.3	8.17	0.48(0.29,0.79)	0.004
Solanaceous fruit vegetables(4)	−0.8	0.3	9.92	0.45(0.27,0.74)	0.002
Livestock(2)	1.3	0.4	12.44	3.63(2.78,6.53)	<0.001
Livestock(3)	0.6	0.3	5.27	1.76(1.08,2.86)	0.023
Livestock(4)	0.5	0.2	4.81	1.60(1.05,2.45)	0.029
Daily drinking water(3)	−1.4	0.5	7.06	0.26(0.09,0.68)	0.008
Daily drinking water(4)	−1.3	0.5	5.87	0.28(0.10,0.77)	0.016
Life behavior					
Duration of hobbies(2)	−1.5	0.2	48.04	0.24(0.16,0.35)	<0.001
Duration of hobbies(3)	−0.8	0.2	11.52	0.45(0.28,0.71)	0.001
Duration of hobbies(4)	−1.3	0.3	26.61	0.28(0.17,0.45)	<0.001
Emotion in life(2)	0.6	0.2	9.45	1.80(1.24,2.62)	0.002
Emotion in life(3)	0.6	0.3	4.96	1.80(1.07,3.05)	0.027
Emotion in life(4)	1.5	0.5	8.68	4.42(2.71,7.46)	0.003
Religion(1)	1.1	0.3	10.16	2.90(1.56,5.13)	0.002
Sleep time point(2)	−0.8	0.2	12.28	0.43(0.27,0.69)	<0.001
Effects of health products					
Regulating endocrine(2)	−1.5	0.3	19.19	0.23(0.11,0.43)	<0.001
Beauty products					
Skin−care products(2)	−2.1	0.3	43.62	0.13(0.07,0.23)	<0.001
Skin−care products(3)	−1.4	0.2	36.43	0.24(0.15,0.38)	<0.001
Sun cream use(3)	−1.5	0.5	11.72	0.22(0.08,0.50)	0.001
Milky lotion use(2)	1.3	0.4	14.32	3.82(2.92,5.73)	<0.001
Eye cream use(2)	−2	0.4	22.94	0.14(0.06,0.31)	<0.001
Eye cream use(3)	−1	0.3	8.17	0.38(0.19,0.72)	0.004
Essence use(3)	−1.4	0.4	13.24	0.24(0.11,0.50)	<0.001

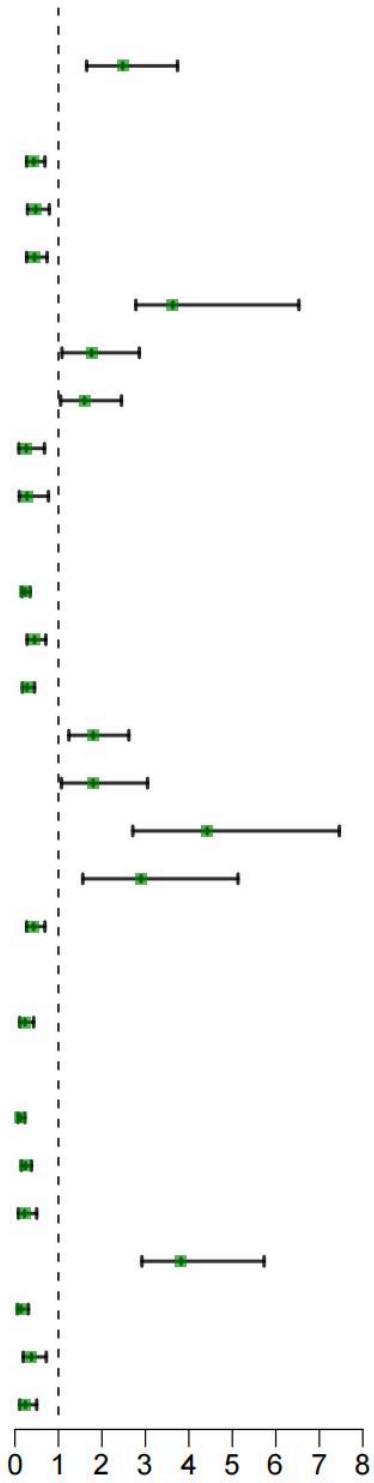

Figure 1

Forest plot of stepwise logistic regression model (comparison with variables assigned 1)

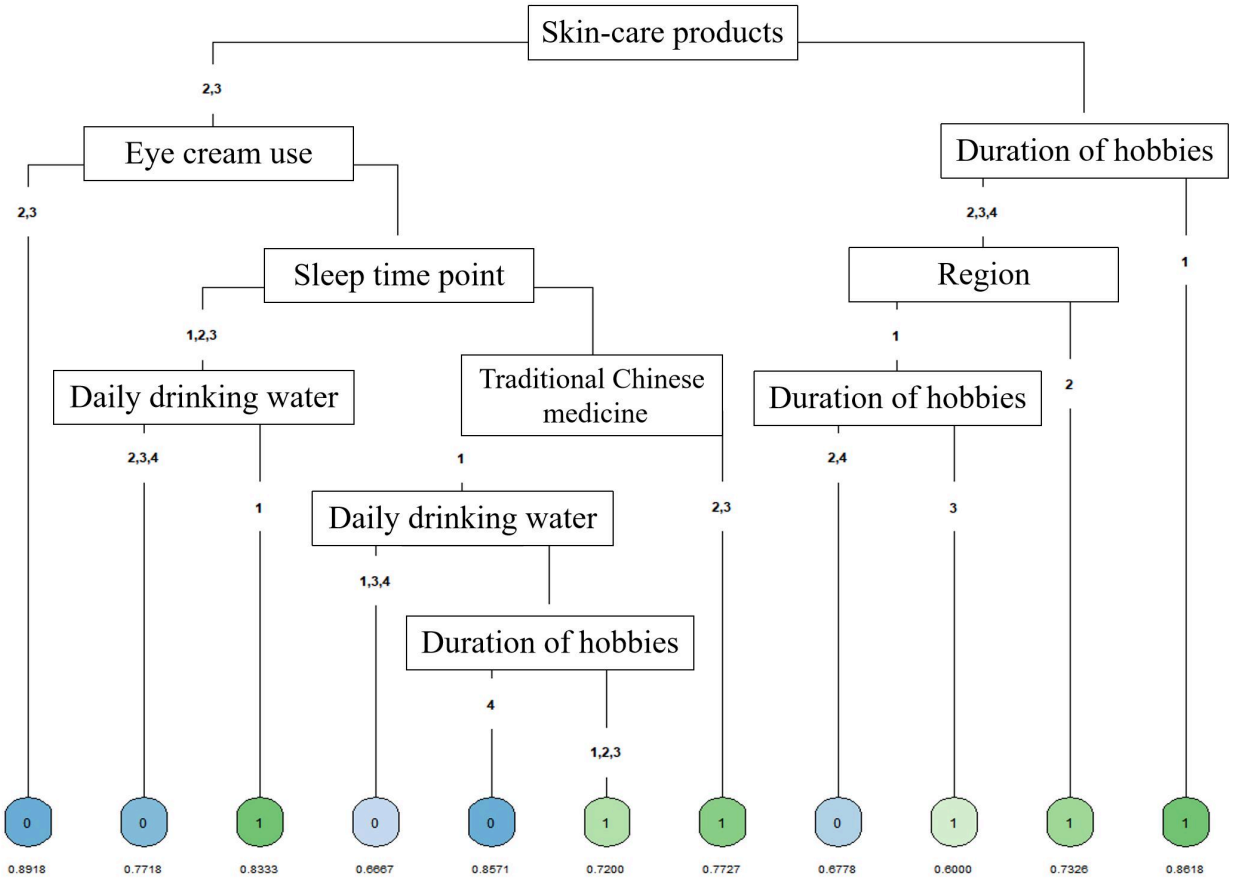

Figure 2

DT model visualization results

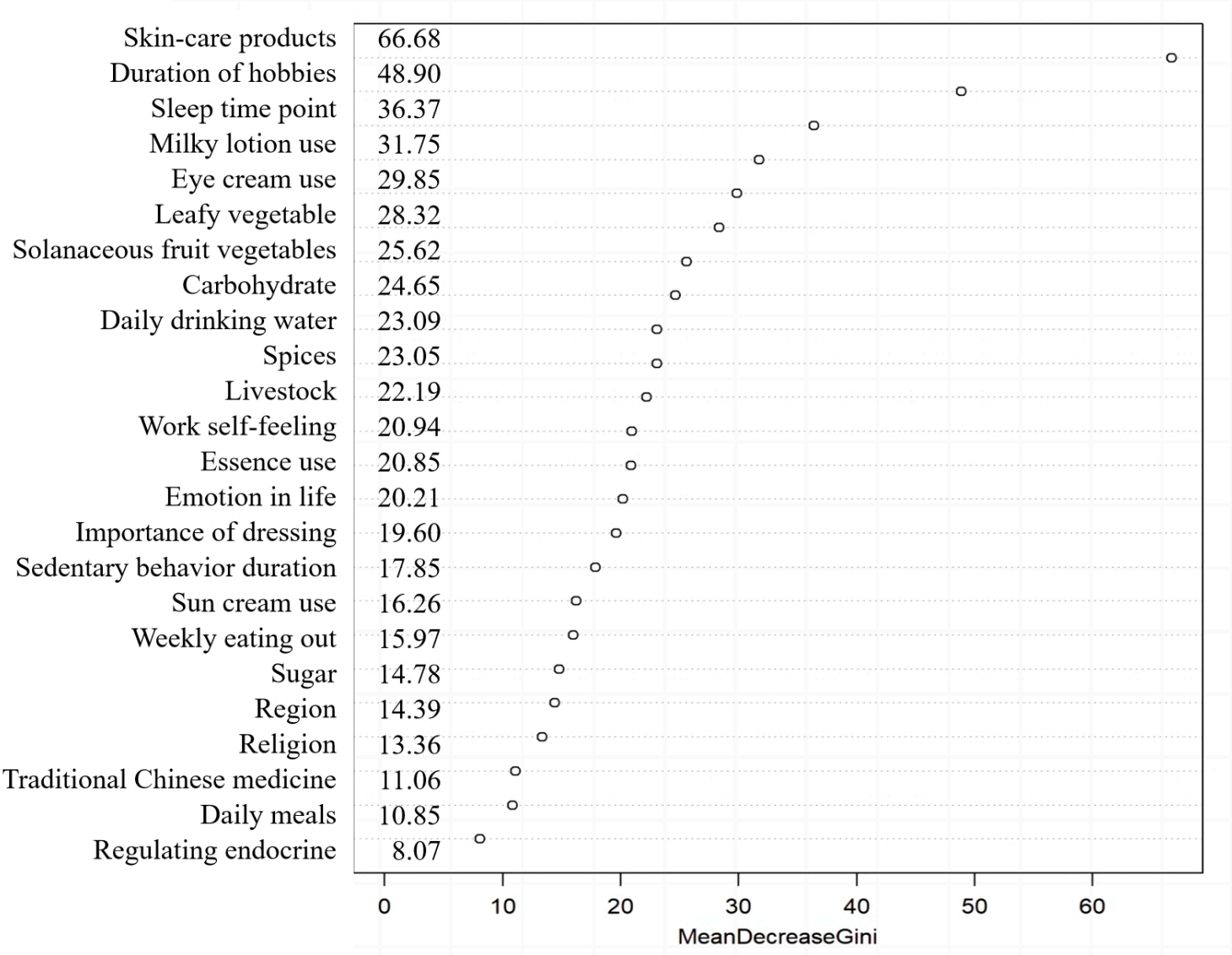

Figure 3

Random forest model variable importance chart

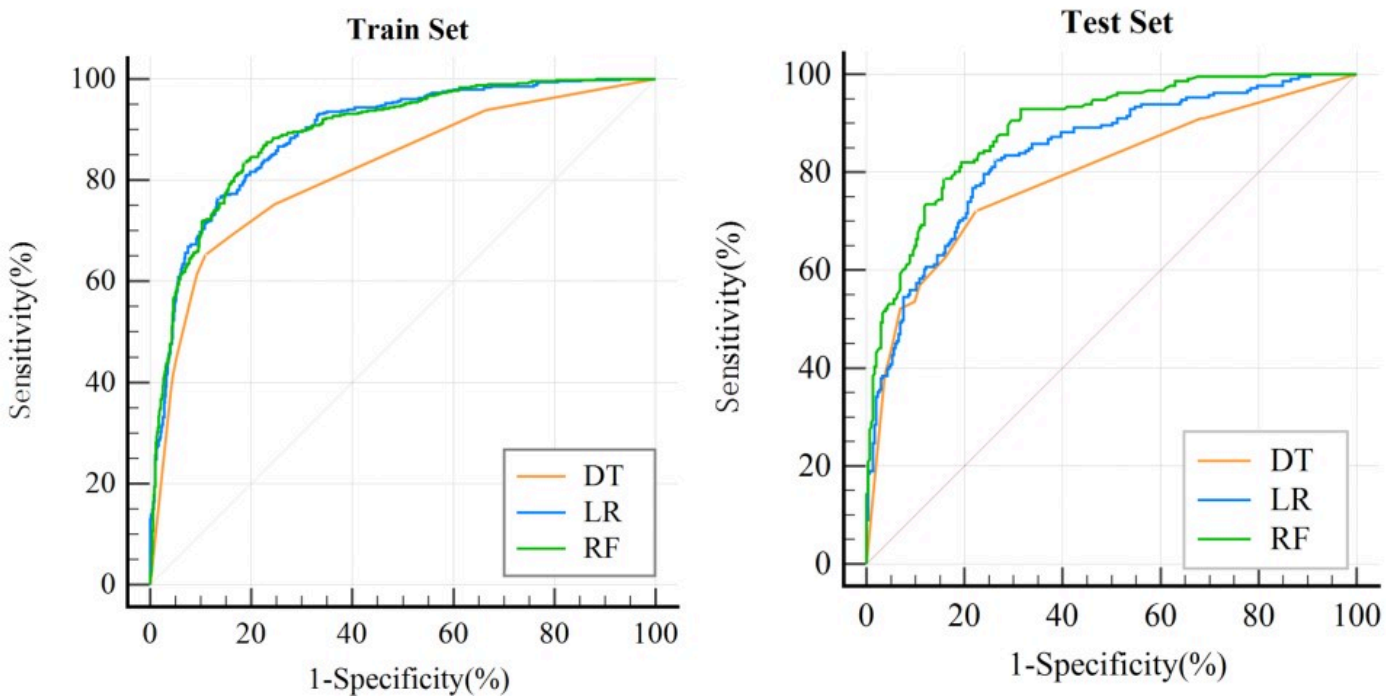

Figure 4

ROC curves of three model in the training set and the test set

Supplementary Files

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- supplement.docx