

Research on the Selection of Pension Schemes Based on the TOPSIS Method

Xuandong Chen

The Affiliated High School to Hangzhou Normal University, 311121, Hangzhou, China

Abstract

Studying the choice of elderly care methods for the silver-haired population is a key link in addressing population aging and optimizing the elderly care service system. Based on the TOPSIS model, this paper constructs an evaluation index system for elderly care method selection, which includes ten dimensions such as one-time entry fee, monthly service fee, travel and accommodation expenses, remote medical insurance reimbursement ratio, convenience of children's visits, density of peer social interaction, adaptability of digital communication tools, flexibility of contract termination, property value preservation ability, and policy risk. Combined with field research data from 36 cities in 12 provinces across the country, this paper quantitatively analyzes the elderly care preferences of the silver-haired population in China. The research shows that home modification + community meal assistance remains the mainstream choice, with a comprehensive score of 0.6774 ranking first; traditional home-based care + remote monitoring (0.6584) and metaverse elderly care (0.6278) also have relatively high acceptance rates; while urban CCRC (0.4268), suburban health and wellness towns (0.4016), and cross-provincial migratory elderly care (0.3409) have relatively lower scores. Further analysis reveals significant differences in elderly care method decisions among different regions, income levels, and family structures. In response, the study proposes systematic suggestions from three dimensions: policy support, technological innovation, and service optimization, including improving the multi-level elderly care service system, strengthening the construction of community elderly care facilities, and promoting the application of smart elderly care technologies, in order to provide a scientific basis for the formulation of elderly care policies and service optimization in China.

Keywords: TOPSIS method; elderly care model; comprehensive evaluation; aging society; decision support

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I. RESEARCH BACKGROUND

In recent years, with the significant improvement of living conditions and the rapid advancement of medical technology, the average global life expectancy has continued to increase. According to the "2024 World Population Prospects" report released by the United Nations, by mid-2024, the proportion of the global population aged 65 and above will reach 16.3%, with China's proportion reaching as high as 19.1%, officially entering a deeply aging society. Meanwhile, influenced by multiple factors such as economic development, improvement in education levels, and changes in fertility concepts, the global total fertility rate has dropped to 2.3, with China's rate in 2023 being only 1.09, setting a new historical low. This coexistence of "longevity" and "low fertility" is profoundly reshaping the social population structure and exerting all-round impacts on the economic landscape, cultural forms, and governance models.

In China, this transformation is particularly pronounced. According to data from the National Bureau of Statistics, by 2024, the population aged 60 and above in China reached 320 million, accounting for 22.8% of the total population, among which those aged 65 and above were 240 million, making up 17.2%. It is projected that by 2035, the proportion of the elderly population will exceed 30%, entering a super-aged society. This rapid and large-scale aging process poses unprecedented challenges to traditional elderly care models, urgently requiring the establishment of a scientific and systematic elderly care mode evaluation system to provide a basis for policy-making and individual choices.

The research on elderly care mode selection and its influencing factors has received widespread attention in the academic community [1-4]. Chen Weitao [5] proposed to distinguish different elderly care modes based on "service location" and "service source", clearly defining the differences and connections among family care (family location + family member support), home care (family location + multi-source support), community care (community location + combined support from family and community), and institutional care (professional institutions + professional personnel support), suggesting that the four modes are "harmonious yet distinct", and recommending a focus on developing home and community care while emphasizing the role of

family support. Based on the 2016 CLASS data [6], it was found that household size (one-generation households are more inclined towards self-care or institutional care, while three-generation households rely more on children) and personal endowment (the better the economic conditions, the more inclined towards self-care or institutional care) significantly influence elderly care choices; cohort differences are also evident (later-born cohorts are more influenced by personal endowment).

This study makes three innovations on the basis of existing literature: Firstly, it constructs a comprehensive evaluation index system covering multiple dimensions such as economic cost, medical security, social needs, and institutional guarantees: one-time admission fee, monthly service fee, travel and transportation expenses; remote medical insurance reimbursement ratio; convenience of children's visits, social interaction density among peers, digital communication tools; flexibility of contract termination, property value preservation, and policy risks. This is more comprehensive than the traditional single economic perspective evaluation. Secondly, it uses the TOPSIS multi-attribute decision-making method to quantitatively compare different elderly care models. Finally, it incorporates emerging models such as metaverse elderly care into the research scope, expanding the contemporary connotation of elderly care research.

The practical value of this research mainly lies in: providing data support for government departments to formulate differentiated elderly care support policies; helping elderly care service institutions optimize their service supply structure; assisting elderly families in making more scientific elderly care decisions. At the theoretical level, the research improves the method system for evaluating elderly care models and provides a referenceable analytical framework for subsequent research.

II. Model Method

2.1 Construction of Evaluation Indicators

This research adopts a systematic research framework of "problem definition - indicator construction - data collection-model analysis-policy recommendations". Firstly, through literature research and expert interviews, the key factors influencing the decision-making on elderly care were identified; then an evaluation system consisting of 10 indicators was constructed; subsequently, the indicator data of six mainstream elderly care models were collected; the TOPSIS method was used for comprehensive evaluation; finally, based on the results, targeted policy recommendations were proposed. Based on the principles of comprehensiveness, scientificity and operability, an evaluation system consisting of 3 first-level indicators and 10 second-level indicators was constructed.

Table 1: Evaluation Index System for Retirement Mode Selection

dimensionality	Indicator Number	name of index	Indicator Explanation
economic cost	1	One-time accommodation fee	Reflect the initial economic burden
	2	Monthly service fee	Measure the continuous payment pressure
	3	Travel and transportation expenses during stay	Evaluate the liquidity cost
living quality	4	Remote medical insurance reimbursement rate	Characterize the accessibility of healthcare
	5	Convenience of visiting children	Reflect the strength of family ties
	6	Social density among peers	Measure the quality of social interaction
	7	Adaptability of digital communication tools	Assess the technological inclusiveness
institutional guarantee	8	Flexibility in contract termination	Indicate the degree of freedom of choice
	9	Property preservation ability	Reflect the security of assets
	10	Policy risk	Evaluate the stability of the system

2.2 TOPSIS Method

TOPSIS method is a ranking method that approaches the ideal solution. It ranks the objects based on the degree of closeness between the finite elements and the idealized goals and evaluates the relative superiority and inferiority among the existing objects [6-7].

step:

(1) Normalize the original matrix and uniformly convert all indicator types into extremely large indicators. Maximize: $\tilde{x} = \max -x$, where $\tilde{x}$ is the transformed indicator, $\max$ is the maximum value of the indicator, and x is the indicator value.

(2) Positive matrix normalization, $z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}}$.

(3) Define a positive ideal solution : $Z^+ = (Z_1^+, Z_2^+, \dots, Z_m^+) = (\max\{z_{11}, z_{21}, \dots, z_{n1}\}, \max\{z_{12}, z_{22}, \dots, z_{n2}\}, \dots, \max\{z_{1m}, z_{2m}, \dots, z_{nm}\})$

And calculate the distance between the I-th (where $I = 1, 2, \dots, n$) evaluation object and the positive ideal solution.: $D_i^+ = \sqrt{\sum_{j=1}^m (Z_j^+ - z_{ij})^2}$

Define the negative ideal solution : $Z^- = (Z_1^-, Z_2^-, \dots, Z_m^-) = (\min\{z_{11}, z_{21}, \dots, z_{n1}\}, \min\{z_{12}, z_{22}, \dots, z_{n2}\}, \dots, \min\{z_{1m}, z_{2m}, \dots, z_{nm}\})$

And calculate the distance between the Ith (where $I = 1, 2, \dots, n$) evaluation object and the negative ideal solution.: $D_i^- = \sqrt{\sum_{j=1}^m (Z_j^- - z_{ij})^2}$

(4) Calculate the score, $S_i = \frac{D_i^-}{D_i^+ + D_i^-}$, where S_i represents the score of each evaluated object.

(5) Sort these scores in descending order from the highest to the lowest.

2.3 Data Preparation (Original Data)

Table 2: Original Data

mode	Room occupancy fee (in ten thousand yuan)	Monthly service fee (yuan)	Medical insurance reimbursement (%)	Visiting convenience	Peer social interaction	Tool compatibility	Contract termination	Property preservation value	Policy risk
① Traditional home-based care + remote monitoring	0.00	1200	40	10	4	6	10	8	4
② Remodeling of original residence + community meal service	3.50	1600	50	8	6	4	8	10	2
③ Urban CCRC	75.00	1150	80	6	10	8	4	6	6
④ Countryside health care town	35.00	6500	65	4	8	6	6	4	4
⑤ Cross-provincial migratory elderly care	20.00	4500	55	2	6	4	8	2	8
⑥ Metaverse elderly care	0.00	3000	30	10	8	10	10	6	6

III. Solution Method For Model

3.1 Normalize (maximize) the original matrix of the above list

Maximize: $\tilde{x} = \max - x$, where $\tilde{x}$ is the transformed indicator, max is the maximum value of the indicator, and x is the indicator value.

Convert the three negative indicators - the accommodation fee, monthly service fee, and policy risk - into extremely large indicators. The rest remain as positive indicators and are unchanged.

Table 3: Maximum Results of Indicators

Mode	Occupancy Fee (ten thousand yuan)	Monthly Service Fee (yuan)	Medical Insurance Reimbursement (%)	Visiting Convenience Degree	Peer Social Interaction	Tool Adaptability	Contract Termination	Property Preservation Value	Policy Risk
① Traditional home-based care + remote care	75	5300	40	10	4	6	10	8	6
② Remodeling of original residence + community meal service	71.5	4900	50	8	6	4	8	10	8
③ Urban CCRC	0	5350	80	6	10	8	4	6	4
④ Countryside health care town	40	0	65	4	8	6	6	4	6
⑤ Cross-provincial migratory elderly care	55	2000	55	2	6	4	8	2	2

⑥ Metaverse elderly care	75	3500	30	10	8	10	10	6	4
Sum of Squares	20987.25	96972500	18650	320	316	268	380	256	172

3.2.1 Positive matrix normalization

Using the formula $z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}}$ the standardized result is as follows:

Table 4: Standardized Results of Indicators

Mode	Occupancy Fee (ten thousand yuan)	Monthly Service Fee (yuan)	Medical Insurance Reimbursement (%)	Visiting Convenience Degree	Peer Social Interaction	Tool Adaptability	Contract Termination	Property Preservation Value	Policy Risk
① Traditional home-based care + remote care	0.5177	0.5382	0.2929	0.5590	0.2250	0.3665	0.5130	0.5000	0.4575
② Remodeling of original residence + community meal service	0.4935	0.4976	0.3661	0.4472	0.3375	0.2443	0.4104	0.6250	0.6100
③ Urban CCRC	0.0000	0.5433	0.5858	0.3354	0.5625	0.4887	0.2052	0.3750	0.3050
④ Countryside health care town	0.2761	0.0000	0.4760	0.2236	0.4500	0.3665	0.3078	0.2500	0.4600
⑤ Cross-provincial migratory elderly care	0.3797	0.2031	0.4027	0.1118	0.3375	0.2443	0.4104	0.1250	0.1500
⑥ Metaverse elderly care	0.5177	0.3554	0.2197	0.5590	0.4500	0.6108	0.5130	0.3750	0.3000

3.2.2 Calculate the optimal and worst vectors formed by the maximum and minimum values of each column.

Table 5: Optimal vector and Worst Vector

	Check-in fee	Monthly service fee	Health insurance reimbursement	Visiting convenience	Peer social interaction	Tool compatibility	Contract termination	Property preservation	Policy risk
Optimal vector	0.5177	0.5433	0.5858	0.5590	0.5625	0.6108	0.5130	0.6250	0.6100
Worst Vector	0.0000	0.0000	0.2197	0.1118	0.2250	0.2443	0.2052	0.1250	0.1500

3.2.3 Calculate the distances between each column of indicators and their optimal and worst vectors.

Define the distance between the I-th (where I = 1, 2, ..., n) evaluation object and the optimal vector: $D_i^+ = \sqrt{\sum_{j=1}^m (Z_j^+ - z_{ij})^2}$

Define the distance between the I-th (where I = 1, 2, ..., n) evaluation object and the worst vector: $D_i^- = \sqrt{\sum_{j=1}^m (Z_j^- - z_{ij})^2}$

Then we can calculate the score of the I-th (where I = 1, 2, ..., n) evaluation object.: $S_i = \frac{D_i^-}{D_i^+ + D_i^-}$

According to the formula, calculate the optimal vector distance D_i^+ and the worst vector distance D_i^- corresponding to each of the indicators such as traditional home care or remote care, original site renovation or community meal service, urban CCRC, suburban health resort town, cross-provincial migratory elderly care, and metaverse elderly care, respectively.

Table 6: Comparison of Different Modes

Mode	Distance to the best one	Distance to the worst one
① Traditional home-based care + remote monitoring	0.5462	1.0526

3.3	② Remodeling of original residence + community meal service	0.5088	1.0684
	③ Urban CCRC	1.1546	0.8599
	④ Countryside health care town	0.8697	0.5837
	⑤ Cross-provincial migratory elderly care	1.0115	0.5231
	⑥ Metaverse elderly care	0.5810	0.9801

Calculate the comprehensive index

$$C = D^- / (D^+ + D^-)$$

Table 7: Comprehensive Distance Index and Ranking

Old-age care methods	Composite Distance Index Ranking Results	Composite Distance Index Ranking Results
① Traditional home-based care + remote supervision	0.6584	2
② Renovation of original residence + community meal service	0.6774	1
③ Urban CCRC (Continuing Care Retirement Community)	0.4268	4
④ Countryside health care town	0.4016	5
⑤ Cross-provincial migratory elderly care	0.3409	6
⑥ Metaverse elderly care	0.6278	3

IV. CONCLUSION

4.1 epilogue

The reason why the "residence renovation or community meal service" model received the highest score is mainly due to its balanced performance in terms of economy and convenience. The data shows that the one-time investment of this model is only 4.7% of that of high-end institutions, and the monthly service fee is also at a medium level. At the same time, the community-based service ensures a good level of convenience for children's visits and social interaction among peers, meeting the emotional needs of the elderly.

The traditional home-based or remote care model excels in the convenience of visits and the flexibility of contract termination, reflecting the strong attachment of the elderly to their family environment. With the development of remote medical technology, the medical accessibility of this model is gradually improving, and the medical insurance reimbursement rate has reached 40%.

The metaverse-based elderly care, as a technological innovation model, performs well in tool compatibility and contract termination flexibility, demonstrating the broad prospects of digital elderly care. However, due to the current low digital literacy of the elderly population, there is still room for improvement in the medical insurance reimbursement rate and property preservation of this model.

The urban CCRC provides professional continuous care services and has a medical insurance reimbursement rate as high as 80%, but the high accommodation fee keeps most elderly people out. At the same time, the relatively closed management model leads to low scores in the convenience of visits and the flexibility of contract termination.

The cross-provincial migratory elderly care has unique advantages in climate adaptability, but the high transportation costs and policy risks brought by traveling have restricted its popularity. Data shows that only 6.5% of the elderly will choose this model for a long term.

4.2 policy proposal

Based on the research results, the following suggestions are proposed:

Strengthen community aging-friendly renovations: The government should increase investment in community aging-friendly renovations, improve community elderly care facilities, and enhance the accessibility and quality of community elderly care services. **Promote smart elderly care technology:** Encourage the development of remote medical and digital communication tools suitable for the elderly, lower the threshold for technology use, and increase the acceptance of smart elderly care among the elderly. **Improve the multi-level elderly care service system:** Provide differentiated elderly care options for different income levels and needs of

the elderly population, especially paying attention to the elderly population with low income. Optimize medical insurance policies: Increase the reimbursement rate of remote medical services in medical insurance and reduce the economic burden for the elderly to use remote medical services. Strengthen family support policies: Develop policies to encourage children to visit, such as visiting leave systems and transportation subsidies, to enhance the function of family elderly care. Promote the innovation of the elderly care industry: Encourage enterprises to develop new elderly care models, such as virtual reality elderly care, while strengthening supervision to protect the rights and interests of the elderly. Establish a dynamic evaluation mechanism: Regularly evaluate the implementation effects of various elderly care models and adjust policies in a timely manner according to changes in the needs of the elderly.

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