

# Research on the evaluation of the quality of elderly services based on the entropy-rank sum ratio method

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**Abstract:** *Objective: To study the differences in the quality of elderly services in various regions of China, and to provide reference for the high-quality development of elderly services in various regions; Method: Combining the existing research results, using the entropy weight-rank sum ratio method, optimizing the evaluation system of the quality of elderly services in China, analyzing the empirical data on the effectiveness of elderly services in 31 provinces and municipalities (autonomous regions) in China from three aspects: economic status, medical level and social security, and The results: most of the regions with the highest economic ranking also rank high in terms of the quality of elderly services; the majority of regions have significant differences between the level of medical care and the quality of elderly services; social security has a greater impact on the quality of elderly services, with 85% of the regions having a similar level of social security and the quality of elderly services; Conclusion: The economy should be steadily developed to increase the content of regional elderly care resources; medical services should be closely adapted to the current situation of regional elderly care to promote the progress of elderly care services; social security should be comprehensively improved to provide multiple support for elderly care services. It is suggested that the economic policy should be reasonably regulated, the supply of quality medical resources should be increased, the construction of elderly service infrastructure should be accelerated, and talents for elderly service should be cultivated to promote the high-quality development of elderly service in China.*

**Keywords:** *elderly services; regional differences; entropy rank sum ratio method; influencing factors*

## 1. Introduction

As China's population ages, it becomes increasingly important to deal with the issue of population ageing, which reached 10% at the end of 2000 and has officially entered an ageing society, and is characterised by a huge elderly population, a high growth rate of ageing, an inverse urban-rural ratio of the elderly population and obvious inter-provincial differences in ageing<sup>[1]</sup>. The report of the 20th Party Congress points out that the development of the elderly care business and the elderly care industry should take "implementing the strategy of actively coping with the ageing of the population, developing the elderly care business and the elderly care industry, and realizing the basic elderly care services for all elderly people" as the basic direction, vigorously promoting the coordinated development of the elderly care business and the elderly care industry, developing universal elderly care services, building a home This paper, on the basis of existing research, aims at developing a system of elderly care services that is coordinated with community institutions and combined with medical care and health care. Based on the existing research, this paper uses the entropy power ranking ratio method to evaluate and analyse the effectiveness and differences in the governance of the quality of elderly services in three aspects: economic status, medical level and social security, and proposes corresponding recommendations, with a view to providing reference and reference for provinces and cities in China to better carry out the work of elderly services, better meet the diversified and hierarchical needs of the elderly and better formulate the strategy of elderly services in the future. This study is intended to provide reference and reference for the better implementation of elderly services in China, the better meeting of the diversified and hierarchical needs of the elderly and the better formulation of elderly services strategies by provinces and municipalities in China.

## 2. Construction of a quality evaluation system for elderly care services

Many scholars have conducted studies on the construction of the evaluation system of the quality of elderly care services. Yang Baoqiang et al<sup>[2]</sup> constructed an index system for the supply capacity of rural elderly services from three perspectives: economic support capacity, medical and health service capacity and social security capacity; Guo Hongyan et al<sup>[3]</sup> evaluated the service quality of elderly institutions from three aspects: quality of management system and facilities and equipment, quality of basic services and quality of health management of the elderly; Wang Xuehui et al<sup>[4]</sup> constructed an index system for the supply of rural elderly services from three perspectives: home care, community care and institutional care on the basis of expert guidance and relevant studies; Zhu Liang and Yang Yang constructed an index system for the supply of rural social elderly services in China from three perspectives. Zhu Liang and Yang Xiaojiao<sup>[5]</sup> constructed a service quality evaluation system for the supply of medical and nursing care centres in rural areas in China based on three aspects: service structure quality, service process quality and service result quality through expert consultation and questionnaire distribution. The system is based on three aspects: service structure quality, service process quality and service outcome quality. Through comparative research, it is found that most of the existing studies on the evaluation system of elderly care services have problems such as a general evaluation index system and incomplete evaluation coverage, which are likely to produce one-sided evaluation results and there is room for further optimization. Based on many existing research results, this paper constructs an evaluation system for the quality of elderly services, and the specific steps are as follows: The first step is to select the core elements. Using the literature statistics method, we manually analysed and screened the literature with the key words "elderly + comprehensive evaluation" and "elderly + index system", and finally determined the core elements that affect the quality of elderly services: supply, medical services and social security. Among them, supply refers to the economic development of the region, medical services refers to the medical resources that the region can provide, and social security refers to the basic service facilities or forms of services related to elderly care services in the region. The second step is to determine the evaluation indicators. The three core elements are further explored to obtain the indicators that can be used for the construction of the system, and the indicators are comprehensively screened to obtain the final evaluation indicators. Based on the existing research results, relevant national policies and relevant data from national yearbooks, this paper selects indicators for the three core elements and follows the three principles of purposefulness, scientificity and representativeness to construct a system of indicators for the quality of elderly services, with the three core elements as the primary indicators and the corresponding secondary indicators under each primary indicator, as shown in Table 1. The third step is to evaluate the index system. The feasibility of the index system was assessed through validity analysis. The result of the validity analysis using SPSS software was 0.526, indicating that the index system is feasible and can be used to comprehensively evaluate the quality of elderly care services in various regions.

Table 1: System of indicators for the assessment of elderly services

System of indicators for the assessment of elderly services	
Tier 1 indicators	Tier 2 indicators
A Economic situation	A1 Gross regional product (billion yuan)
	A2 Regional general expenditure (billion yuan)
	A3 Regional general revenue (billion yuan)
B Medical standards	B1 Number of health care facilities (units per 10,000 people)
	B2 Number of beds in health institutions (beds per 10,000 people)
	B3 Number of health personnel (persons per 10,000)
C Social Security	C1 Number of elderly care institutions (units per 10,000 people)
	C2 Number of beds in elderly care institutions (beds per 10,000 people)
	C3 Number of employees in elderly care institutions (persons per 10,000)
	C4 Number of community service providers (units per 10,000 people)
	C5 Number of beds in community services (beds per 10,000 people)
	C6 Number of employees in community services (persons per 10,000)
	C7 Activity facilities for the elderly (units per 10,000 people)
C8 Subsidy for elderly care services (%)	
	C9 Number of rehabilitation medical services (visits per 10,000 people)
	C10 Financial situation of elderly care institutions (10 thousand yuan)

1) As there are missing data for some of the secondary indicators of "social security", they are filled

in by summing the data from the previous and following years and taking the average value.

2) Since indicators such as the number of health workers in this system are directly related to their overall number of units and overall scope, it is not appropriate to make direct comparisons, so their average indicators are used as the basic form of measurement indicators.

### 3. Evaluation process and results of the quality of elderly care services

#### 3.1 Data sources

Due to the absence of some social indicators in the China Civil Affairs Statistical Yearbook 2021, in order to complete the evaluation more comprehensively, this paper selects the China Civil Affairs Statistical Yearbook 2020 and the annual data of the National Bureau of Statistics by province, among which economic and medical care come from the National Bureau of Statistics and social security from the Statistical Yearbook.

#### 3.2 Comprehensive evaluation process

Entropy Weight Method (EWM) is an objective weighting method, the core idea of which is to derive the information entropy of data based on the confusion of each data indicator, and then use its information entropy to calculate the weights<sup>[6]</sup>. This method can make full use of the data characteristics to obtain objective indicator weights and avoid the interference of subjective factors. Rank Sum Ratio (RSR) is a comprehensive evaluation method that can carry out comprehensive level analysis of multiple indicators of different nature and magnitude<sup>[7]</sup>, and has been widely used in China's health care field for comprehensive evaluation of multiple indicators and statistical prediction forecasting. On the basis of a full understanding of the basic characteristics of the data, this paper proposes the entropy-rank-sum-ratio method, which determines the weight of each indicator by the entropy-weight method and codifies the rank score of the evaluation object by the rank-sum-ratio method, effectively reducing the special requirements of indicator selection and the influence of outliers to achieve comprehensive evaluation.

The basic principle of the entropy-rank sum ratio method is as follows.

Suppose there are  $n$  evaluation objects, each object corresponds to  $m$  evaluation indicators, and the data corresponding to each evaluation indicator of each evaluation object is arranged into a raw data table with  $n$  rows and  $m$  columns, which is noted as the raw matrix  $X$ ,  $X=(x_{ij})_{n*m}$  ( $i=1, 2, 3, \dots, n; j=1, 2, 3, \dots, m$ ), where  $x_{ij}$  indicates the data of the  $i$ th evaluation object on the  $j$ th indicator. Since there are 31 regions in this paper, and there are 16 indicators in the comprehensive evaluation system, let  $n=31$  and  $m=16$ .

Step one, use the entropy weighting method to find weights. Find the entropy value and entropy weight of each evaluation index, the smaller the entropy value, the larger the entropy weight should be. Find the entropy value  $E_j$  and entropy weight  $W_j$  of the  $j$ th indicator of the  $i$ th evaluation object by the following formula:

$$E_j = -\frac{1}{\ln n} \sum_{i=1}^n p_{ij} \ln p_{ij} \left( p_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}} \right) \quad (1)$$

$$W_j = \frac{g_j}{\sum_{i=1}^n g_j} (g_j = 1 - E_j) \quad (2)$$

Step two, compile the rank. The rank of each evaluation object under each indicator of the original matrix  $X$  is compiled, and the rank matrix  $R=(R_{ij})_{n*m}$  is obtained in accordance with the principle of "benefit indicators from small to large, cost indicators from large to small, and equal data of the same indicator compiled in average rank".

Step three, calculate the weighted rank sum ratio (WRSR). The summation of the rank of all indicators under each evaluation object is carried out separately, using the weights obtained in the first step in the following formula, where  $w_j$  is the weight of the  $j$ th indicator.

$$WRSR_i = \frac{1}{n} \sum_{j=1}^m w_j R_{ij} \quad (3)$$

Step four, ranking. The WRSR value of each evaluation object is ranked according to the value obtained in the third step, with a higher value indicating a higher level.

3.3 Integrated evaluation results

The indicator system and evaluation results obtained in this paper are shown in Figure 1, which reflects the corresponding weights of each indicator, among which the per capita subsidy for elderly services (20.98%) and the number of rehabilitation and medical services per capita (15.49%) have a large weighting, while the remaining indicators have a relatively small weighting. The calculation shows that the sum of the economic weighting is 19.33%, the sum of the health care weighting is 7.21% and the social security weighting is 73.46%.

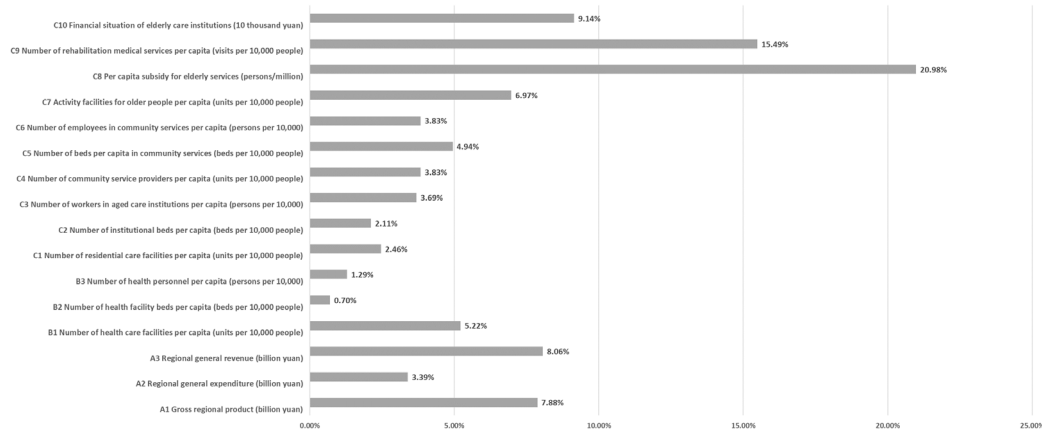


Figure 1: System of indicators for the evaluation of elderly services

Figure 2 shows a bar chart of provincial scores, where the top 5 regions are Jiangsu (0.825), Guangdong (0.792), Zhejiang (0.744), Beijing (0.709) and Shandong (0.690), with the remaining provinces scoring relatively low.

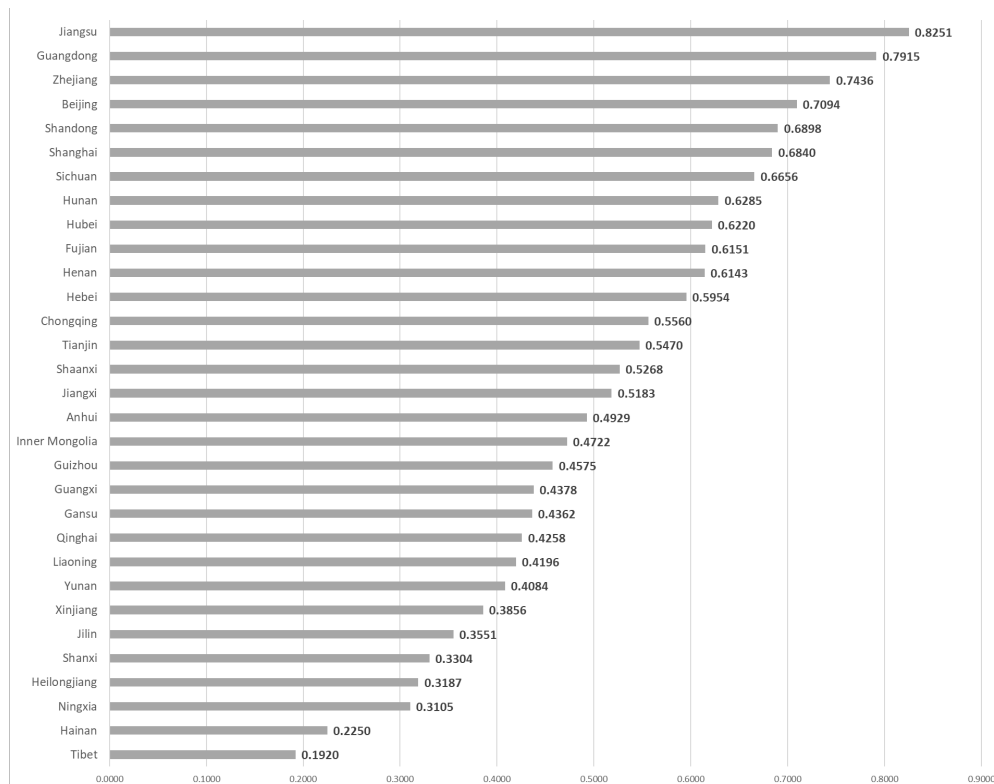


Figure 2: Bar chart of combined scores by province

Table 2 shows the ranking of the regions on the three tier 1 indicators and the overall rating, from which the relationship between the scores of the regions on the three tier 1 indicators and their overall ranking can be seen.

Table 2: Overall ranking by region

Region	Economic Ranking	Medical Ranking	Social Security Ranking	Quality of Elderly Services Ranking
Jiangsu	2	29	1	1
Guangdong	1	16	2	2
Zhejiang	4	24	3	3
Beijing	9	21	4	4
Shandong	3	23	6	5
Shanghai	7	31	5	6
Sichuan	5	19	7	7
Hunan	11	17	9	8
Hubei	8	22	11	9
Fujian	13	11	12	10
Henan	6	14	13	11
Hebei	10	12	14	12
Chongqing	18	26	10	13
Tianjin	22	27	8	14
Shaanxi	16	7	15	15
Jiangxi	15	9	16	16
Anhui	12	30	17	17
Inner Mongolia	21	4	21	18
Guizhou	23	10	20	19
Guangxi	19	13	22	20
Gansu	27	6	18	21
Qinghai	30	2	19	22
Liaoning	14	25	23	23
Yunan	17	18	25	24
Xinjiang	24	3	26	25
Jilin	26	20	24	26
Shanxi	20	5	29	27
Heilongjiang	25	28	27	28
Ningxia	29	8	28	29
Hainan	28	15	30	30
Tibet	31	1	31	31

#### 4. Analysis of variances and influencing factors

##### 4.1 Comprehensive evaluation of overall differences

After analysing the three primary indicators separately, this paper compares the average absolute difference between the ranking of the three primary indicators and the overall ranking of each region, and comes up with the results for the economy (3.16), health care (13.02) and social security (1.29). The other two are slightly more deviant. Combined with the weight distribution of the indicator system, this phenomenon reflects the multi-faceted and multi-dimensional influence of social security on the quality of elderly care services, which is deeper and more effective than the other two, and plays a significant role in the assurance and construction of the quality of elderly care services.

##### 4.2 Comprehensive evaluation of the quality of elderly care services in each region at the economic level

The economic dimension indicators include regional gross domestic product, regional general fiscal expenditure and regional general fiscal revenue, which account for 19.33% of the total indicator system. Looking at the difference between the economic ranking and the comprehensive quality ranking of elderly care services, we find that there are some differences between the two. Among the regions with high economic rankings (1-10), Beijing has a more significant difference, with its economy ranked 9th, while its overall ranking is 4th; among the regions with medium economic rankings (11-20), the more significant difference is Liaoning, with its economy ranked 14th, while its overall ranking is only 23rd;

among the regions with low economic rankings (21-31), Qinghai has a more significant difference compared to other regions, with its economy. By comparing the economic ranking with the quality ranking, it can be seen that most of the regions with the highest economic ranking also have the highest quality ranking, i.e. the more economically developed the region, the higher the quality of elderly services; at the same time, there are some regions where the situation is not the same, mainly because the social security ranking has a greater impact on the overall ranking. The impact of the economy on the quality of elderly care services is mainly reflected in the level of regional supply. The more developed the GDP is, the more abundant and excellent the resources are for the development of the elderly care service industry and the improvement of the quality of elderly care services, so that there are more opportunities to develop a higher level of elderly care service industry for the people of the region and to invest in the construction of elderly care infrastructure.

#### ***4.3 Comprehensive evaluation of the quality of elderly care services by region at the medical level***

The indicators at the medical level include the number of health care institutions, the number of beds in health care institutions and the number of health care personnel, which account for 7.21% of the total indicator system. The difference between the ranking of medical care per capita and the corresponding comprehensive ranking of the quality of elderly care services in each region is large, with an average difference of 12 places, indicating that the quality of elderly care services in each region is not quite in line with the medical care per capita, and that the medical care per capita has less influence on the quality of elderly care services than the economic level and social security. Most of the regions with high medical rankings (1-10) are relatively backward in terms of economic development and insufficient investment in social security, so the overall ranking of the quality of elderly services is low, with the Tibet Autonomous Region ranking first in medical care but last in the overall ranking of the quality of elderly services; most of the regions with medium medical rankings (11-20) have a medium level of overall evaluation of the quality of elderly services, with Guangdong Province having the strongest overall strength. The regions with lower medical rankings (21-31) have stronger economic and social security levels, so the overall ranking of the quality of elderly care services is mostly higher. Among them, Jiangsu Province has the second highest economic level, the first social security level and the first overall rating of the quality of elderly care services; Zhejiang Province has the fourth highest economic level, the third highest social security level and the third overall rating of the quality of elderly care services. The impact of medical care on the quality of elderly care services is mainly reflected in the contribution to the health problems of the elderly, the amount and quality of medical resources are related to the health problems of the elderly, and quality medical resources are a basic need for the healthy life of the elderly. The greater the availability and diversity of medical resources in a region, the greater the choice and access of older people to health care, the more accurate the diagnosis of their problems, the less fear of difficult diseases and the more scientific and efficient the control of their own basic health conditions. The per capita level of medical care is a better indicator of the current state of medical care in a region than the overall level, so it can be seen that compared to other regions, the economically developed regions have a slightly lower level of medical care due to their population density.

#### ***4.4 Comprehensive evaluation of the quality of elderly care services in each region at the social security level***

The indicators at the social security level include subsidies for elderly care services, infrastructure construction for the elderly and the supply capacity of social elderly care services, accounting for 73.46% of the total indicator system. An analysis of the difference between the social security ranking and the overall ranking of the quality of elderly care services shows that the individual social security rankings and the overall ranking of each region are very close to each other. The results show that the level of social security is closely related to the overall quality of elderly care services, and that the level of social security is positively correlated with the overall quality of elderly care services, echoing the results of the grey correlation analysis in the previous section. The role of social security in elderly care services is the largest in relative terms, and is reflected in more diverse and comprehensive areas. The elderly care institutions provide practical daily services to the elderly, giving them daily communication, post-operative rehabilitation and medical protection, and can provide comprehensive and convenient services to the elderly; while the elderly care subsidies mainly provide practical assistance to the elderly in difficulty, so that those who lack the conditions can receive proper care; the elderly care service facilities can provide the necessary venues and conditions for daily activities of the elderly, catering to various interests of the elderly. The facilities provide the necessary space and conditions for daily activities, cater for the various interests of the elderly, add to their enjoyment of life and promote a healthy lifestyle.

These aspects of elderly care are direct and effective, and are key factors in the healthy lives of older people, and have practical implications for the quality of elderly care services.

## 5. Limitations and research outlook

By constructing a comprehensive evaluation system for the quality of elderly services, this paper makes a comprehensive evaluation of the quality of elderly services in each region at three levels: economic, medical and social security. The research results are of practical significance in understanding and assessing the current situation of elderly services in China. At the same time, there are certain limitations in the process of analysis. On the one hand, due to the wide coverage of elderly services, the secondary indicators under the three major aspects cannot fully represent all the contents of each aspect, and the indicator system in this paper can only select the representative ones among them; on the other hand, although the entropy weighting method used in this paper to determine the weights yields objective results, the core point is that the weights are determined through data characteristics, which may not be fully in line with the actual cognition.

In view of the limitations of this paper, the next step is to use more channels to search for information and construct the indicator system, or to consider consulting experts and using more subjective and realistic analysis methods such as hierarchical analysis, in order to obtain more scientific results.

## 6. Conclusions and Recommendations

### 6.1 Conclusions

#### 6.1.1 *A solid economic level is the cornerstone for the development of elderly care services*

The results of the study show that due to the focus of development governance in different regions, the top economic regions are mostly in the top overall ranking, and therefore the quality of elderly services is relatively higher in economically developed regions, i.e. the level of economic affluence has a driving effect on many of the conditions that directly determine old age under the social security system, and thus can have an impact on elderly services. In addition, the "ageing before the rich" is a major pain point that prevents the current generation of older people from having a happy old age and the development of the elderly services industry, and increased economic investment by the government can play a crucial role in solving this pain point. The only way to achieve effective socio-economic progress and to ensure that people's lives are effectively fulfilled is to properly grasp the relationship between ageing and economic standards, and to gradually address the issue of ageing in the process of economic development.

#### 6.1.2 *Complete medical resources are a strong support for the development of elderly services*

In terms of overall level, provinces ranked in the top 10 in the two indicators of the number of beds in health institutions and the number of health personnel all ranked in the top 10 overall, indicating that the more abundant medical resources, the higher the quality of elderly services; in terms of per capita level, provinces with a higher level of medical services per capita, on the contrary, had a lower overall ranking in the quality of elderly services; provinces with a lower level of medical services per capita, on the contrary, had a higher overall ranking in the quality of elderly services. The main reasons for this phenomenon are The main reason for this phenomenon is that the provinces with higher levels of medical services per capita have a smaller elderly population and a lower level of ageing than the economically developed regions, which gives them a comparative advantage in terms of per capita level; however, due to their poor economic development and insufficient investment in social security, they are ranked lower in terms of overall quality of elderly care services. The economically developed regions, however, have a relatively lower per capita ranking due to their larger elderly population and heavier ageing compared to the less economically developed regions. The uneven distribution of health care resources across regions has an impact on elderly services, and this issue is also the focus of national efforts to improve health care in a targeted and multifaceted manner through strengthening health care institutions and improving the capacity of health care services, in order to achieve a higher level of progress.

#### 6.1.3 *A sound social security system is the main driving force behind the development of elderly care services*

The social security system includes a range of national legislation, such as social insurance, assistance and subsidies. The social security indicators in this paper include subsidies for elderly services and the

supply of elderly service infrastructure, and social security is the most important part of the indicators in this paper, reflecting the importance of a sound social security system. 2021 Notice of the State Council on the Issuance of the 14th Five-Year Plan for the Development of the National Ageing Cause and the Elderly Service System It is clearly stated that it is important to build a solid network of social security and subsidised old-age services, improve the basic old-age insurance system, continuously expand the coverage of basic old-age insurance, improve the social assistance and social welfare systems, and improve the social security system to better meet the increasingly rich needs of the elderly in old-age. The significance of these steps is to fundamentally guarantee the basic services to which the elderly are entitled, to provide them with truly convenient, quality and practical assistance and subsidies, and to solve their basic problems.

## **6.2 Recommendations**

### **6.2.1 Reasonable regulation of economic guidelines to actively address ageing issues**

Tackling the issue of elderly care requires a strong role for the government. In order to promote the development and improvement of the quality of regional elderly services, the government needs to further adjust its governance strategy and establish a solid backing for the elderly services industry. On the one hand, it should actively address the issue of ageing and realise the organic combination of economic development and the improvement of the quality of elderly care services in each region. On the other hand, it should firmly grasp the principle that facing the ageing population and economic and social development should go hand in hand, provide support to elderly groups in financial difficulties, always pay attention to the actual needs of the elderly, and firmly combine needs and measures to address the demands at the root.

### **6.2.2 Increase the supply of quality medical resources and rationalise the allocation of medical resources**

The level of medical care is the basis for the implementation of elderly care services in each locality. It is of practical significance for local governments to improve local medical standards in order to promote the development of elderly services and improve the construction of the system. Therefore, each region should increase the supply of quality medical resources based on the actual local situation on the basis of vigorous development of productivity, optimise the layout of medical resources, create an age-appropriate elderly medical service system and improve the quality of elderly services in medical and health institutions. Promote the management of geriatric syndromes in medical and health institutions, improve the convenience of medical institutions and facilitate access to medical treatment for the elderly. Actively develop community and home-based Chinese medicine health services, and use Chinese medicine to add to the health of the elderly.

### **6.2.3 Strengthen the construction of infrastructure and enhance the quality of elderly care services**

The construction of elderly services infrastructure is an important part of improving the quality of elderly services. From the data of the National Bureau of Statistics, it can be concluded that the existing elderly service facilities are still insufficient to meet the needs of the rapidly rising elderly population. In response to the speed of population ageing and the impact of the development process of an ageing society on the infrastructure of elderly care services, governments at all levels should actively promote the renovation and construction of elderly care service infrastructure to effectively enhance the well-being of the elderly and improve the quality of elderly care services. Regions are encouraged to integrate and co-ordinate the use of resources for elderly care service facilities to achieve unified management and operation. Elderly care institutions are encouraged to actively provide community-based elderly care services and actively perform institutional functions to reduce the burden of elderly care.

### **6.2.4 Cultivate talents for elderly care services and fill the talent gap**

Do a good job in building a team of talents for elderly services, and cultivate multi-level and multi-disciplinary professionals for elderly services based on the growing demand for diversified elderly services. With the further seriousness of population ageing, China's elderly service career is developing rapidly, but the construction of the elderly service talent team is relatively slow. Governments at all levels should optimise the training mechanism for elderly service talents and give certain welfare measures to them. At the same time, in order to promote more young people to choose the elderly service industry, the construction of elderly service majors in universities can be promoted and professional and systematic training programmes can be designed.



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