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Qinhuangdao City's Elderly Care Industry Planning Based on the Least Squares Method

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Abstract: This study focuses on the planning of elderly care industry in Qinhuangdao City, utilizing the least squares method to conduct predictive analysis of population aging data, aiming to provide scientific basis for elderly care industry development. The research collected demographic data from 2006 to 2023 in Qinhuangdao City, including birth population, population aged over 60, immigration/emigration population, and permanent resident population. These datasets exhibited distinct linear or exponential trends. Through linear regression analysis using MATLAB, predictions indicate that the population aged over 60 will increase to 931,250 within the next five years, accompanied by required increments of 1,403 elderly care beds and 3,672 medical beds. Considering current shortages in elderly care and medical bed resources, actual future demand may exceed these projections. Recommendations include: increasing government fiscal budgets for elderly services, reducing tax burdens, advancing smart home-based elderly care bed construction, encouraging enterprise renovation of elderly care facilities, and promoting integrated medical-care bed supplies. Additionally, implementing artificial intelligence (AI) technologies to develop intelligent bed management systems could enhance resource utilization efficiency. The study emphasizes that addressing aging population challenges requires countries to refine policies according to national conditions, support elderly care industry and medical service development, and ensure comprehensive care for elderly populations.

Keywords: Aging Population, Least Square Method, Elderly Care Industry, Planning

1. Introduction

With the increasingly severe issue of population aging in global industrialized nations, the number of elderly people continues to rise while fertility rates persistently decline, leading to a growing proportion of elderly populations and intensifying demand for elderly care services. Addressing aging challenges has become a shared priority for industrialized countries worldwide. Analyzing trends in the elderly care industry through rational forecasting methods helps governments formulate and adjust policies, optimize resource allocation, and reasonably invest in funding, infrastructure development, and elderly services. This ensures the most efficient utilization of elderly care resources even amid sustained population aging, thereby meeting the living needs of the elderly while enhancing the quality and efficiency of care services. The healthy development of the elderly care industry is a critical component of sustainable social development, and ensuring proper care for elderly populations serves as a cornerstone for long-term social stability and continuous progress. Consequently, the growth of the elderly care industry has emerged as a vital issue in socioeconomic development, while forecasting its trajectory has become a key research topic worthy of in-depth exploration.

As the elderly population continues to grow, challenges facing the elderly care industry are also multiplying. Research has explored how the industry can effectively integrate with other sectors amid technological revolutions and industrial transformations to address elderly care demands. Studies by Zhu Jing [1] and colleagues note that while progress has been made in policy support, market scale, care demands, and technological innovation, the industry still faces issues such as inadequate standardization and imperfect operational mechanisms. Consequently, they propose strategies including strengthening top-level design, optimizing market environments, adjusting supply-demand structures, and dismantling information silos to foster healthy industry development. Research by Wang Guanyi et al. [2] provides an in-depth analysis of the current state of Beijing's elderly care industry, covering institutional elderly care, community-based care, and related supply systems. The study reveals that Beijing's high and continuously rising elderly population proportion has profound economic implications due to intensifying aging pressures. Thus, they recommend improvement measures such as rational planning and layout, standardizing service quality, cultivating consumer markets, and building professional talent teams to enhance service standards and meet the growing demands of elderly populations.

Furthermore, research by W [3] employed fitting algorithms and BP neural networks to predict future development trends of China's elderly care industry. By collecting data on the elderly population size, urbanization rates, and the willingness of elderly individuals with varying income levels to accept institutional care, the study forecasted the future demand scale for elderly care beds in China. Findings indicate that by 2023, the demand for elderly care beds in urban areas of China will rise significantly. Similarly, research by PJS [4] used the Leslie matrix model to predict the elderly population and analyze demand for elderly care facilities in Chongqing, China. Results reveal that Chongqing faces particularly severe aging challenges, especially in districts such as Wanzhou and Jiangjin, where the large elderly population has led to a demand for care facilities far exceeding current bed capacity, necessitating urgent increases in beds and caregiving staff. Additionally, the study highlights uneven distribution of elderly care facilities in Chongqing, with concentrated resources in urban centers and shortages in peripheral areas. This imbalance has left elderly populations in outskirts underserved, while urban centers experience resource surpluses.

Research by Song [5] delves into the development of the elderly care industry in aging regions against the backdrop of China's intensifying population aging. The study emphasizes that to effectively address elderly care needs, it is crucial to focus on existing market demands and refine services based on elderly preferences. It also notes that government subsidy policies can effectively stimulate private elderly care service provision. Government financial support helps resolve conflicts and disputes, particularly between private and public sectors where conflicting interests often arise, with governments typically balancing these interests effectively. Moreover, governments play a proactive role in market transitions by improving regulatory measures and enhancing elderly payment capacities, underscoring their critical involvement.

The aging population issue extends beyond China and is prevalent in other industrialized nations, such as Spain. Research [4] shows that European countries like Spain similarly face aging challenges in the 21st century, with governments playing pivotal roles. Through policies protecting the elderly, actively promoting elderly care services, and refining healthcare policies, governments have significantly addressed these issues. By analyzing sociodemographic characteristics of elderly populations, the study reveals aging's profound impact on Spain's social structure and its direct influence on the elderly care industry. Sidorenko [8] also examines aging in Madrid, highlighting its severity in developing nations. The research focuses on the formulation process of the Madrid International Plan of Action on Ageing (MIPAA), outlining its key contents and features. Furthermore, it contrasts MIPAA with its predecessor, the 1982 Vienna International Plan of Action on Ageing, emphasizing MIPAA's focus on aging challenges in developing countries. While aging issues in Madrid mirror those in other European nations, MIPAA's detailed analysis offers valuable lessons for crafting international policy frameworks.

Van [9] found that as the elderly population grows, the demand for hospital capacity continues to increase, which may lead to a shortage of hospital beds. The study used hospital discharge and population data from Belgium between 2003 and 2014 to forecast the hospital capacity needs of inpatients aged 75 and above in 2025, and projected the demand changes after 2030 through accelerated aging scenarios. The results show that although shortening the length of hospital stays can relatively control the growth of demand in the short term, from 2030 onwards, the demand for hospital beds will grow exponentially, especially for geriatric and chronic care beds. Therefore, the Belgian government needs to take measures to alleviate the bed shortage problem to cope with the challenges brought by this trend. The study then put forward constructive suggestions such as optimizing hospital resource allocation, developing alternative care models, and strengthening the training of geriatric care professionals.

Mazzola [10] focused on Italy and explored the current situation of population aging in the country and its impact on economic and social policies. The study shows that aging poses challenges to the economic sustainability of Italy, mainly reflected in the increase of the elderly population, the decrease of the working-age labor force, the increase of pension expenditure, and the non-self-care issues of the elderly. To cope with these challenges, Italy has launched the Longitudinal Ageing Study (ILSA) and the "Train The Brain" project, which aim to focus on the quality of life of the elderly and minimize the negative impact of aging on society as much as possible. Although Italy's welfare system is family-centered, with the intensification of aging, the family can no longer independently take on the responsibility of taking care of the elderly, so there is an urgent need for the government to formulate new welfare strategies. The study put forward a number of suggestions, including implementing preventive education from a young age, increasing research investment, building facilities that better meet the needs of the elderly, and reducing the taxes paid by the elderly, while increasing social awareness of aging issues. These methods may make a positive contribution to the sustainable development of Italy.

Béland [11] conducted a detailed analysis of the phenomenon of population aging in France and its impact on policies and research. The article points out that France's aging trend is similar to the EU average, and it is expected that by 2050, the population aged 65 and above will approach 30%, which will bring many challenges and pressures to society. With the increase of the elderly population, the health care system will face a greater burden, and the demand for long-term care will continue to increase. Although France's pension system helps to effectively reduce elderly poverty, France still faces the problem of high costs and how to reasonably control costs, as well as the challenge of early retirement in the labor market. In the field of health and long-term care, the French government has taken a series of measures, including increasing investment in nursing homes and improving geriatric medical services. However, aging research in France is still relatively fragmented and lacks a unified coordination strategy, which is particularly prominent in the context of the increasing importance of European and international networks. The article emphasizes that if France wants to successfully cope with the social problems brought about by the growth of aging, it needs to formulate a more comprehensive and coordinated aging research strategy.

In the field of intelligent elderly care, Zhang [6] proposed a medical optimization quality system based on machine learning algorithms, aiming to improve the quality and efficiency of elderly care services. The system integrates big data, artificial intelligence, and other modern information technologies to optimize the management of elderly care services. The study analyzed the current status of elderly care services and identified several issues, including insufficient service diversity, a single type of service, and an imperfect feedback mechanism in the medical system. There is often a failure to provide feedback, and the opinions and needs of the elderly are not effectively responded to. Subsequently, the study proposed a solution based on machine learning algorithms that can analyze and predict user needs and provide personalized medical services. Moreover, the integration of machine learning and artificial intelligence technologies into practical work has provided a new perspective and method for optimizing elderly care services. The combination of machine learning algorithms and the medical optimization quality system not only enhances the personalization and efficiency of elderly care services but also better meets the individual preferences and needs of the elderly. With the continuous advancement of technology and the widespread application of machine learning and artificial intelligence in many fields, this new method of applying machine learning algorithms to elderly care services has certain reference value and innovative significance for other researchers in choosing methods.

This paper focuses on Qinhuangdao City, where data is collected and compared to analyze the development status and existing problems of the local elderly care industry. The study found that the elderly care industry in this area faces many challenges in terms of institutional supply, service level, and resource allocation. This research not only has certain reference significance for other regions in China but also provides a reference for industrialized countries around the world in dealing with the development issues of the elderly care industry.

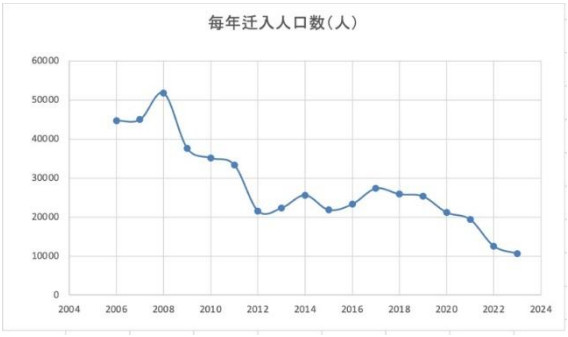
2. Prediction based on linear regression models

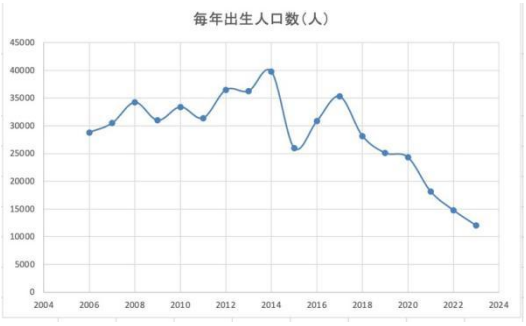
Table 2.1 Summary table of Qinhuangdao City (including counties and districts)

Year	Number of births per year (persons)	Population over 60 years old (10,000 persons)	Number of immigrants per year (persons)	Total resident population (10,000 persons)	Annual emigration (persons)
2006	28807	39.27	44693	290.47	36848
2007	30478	40.96	44977	293	32670
2008	34225	43.09	51765	295.74	45532
2009	30985	45.15	37582	297.8	34886
2010	33400	46.85	35128	299.01	32621
2011	31396	48.93	33339	300.62	29862
2012	36496	50.88	21558	302.16	24382
2013	36269	52.68	22310	304.52	22748
2014	39774	55.2	25607	306.45	20324
2015	26004	59.64	21825	307.32	18307
2016	30840	60.85	23300	309.46	15542
2017	35303	64.18	27344	311.08	16882
2018	28167	67.42	25870	313.42	20317
2019	25112	69.68	25312	314.63	21283
2020	24320	73.26	21190	313.69	20924
2021	18145	75.41	19405	313.43	20839
2022	14770	76.94	12578	309.81	14002
2023	12011	80.72	10628	310.74	12352

The data above are all sourced from the Qinhuangdao Municipal Bureau of Statistics.

By collecting the annual birth population, population aged 60 and above, out-migrants, in-migrants, and the total resident population of Qinhuangdao from 2006 to 2023, graphs can be drawn to analyze the overall trends, as shown in Figure 2.1.





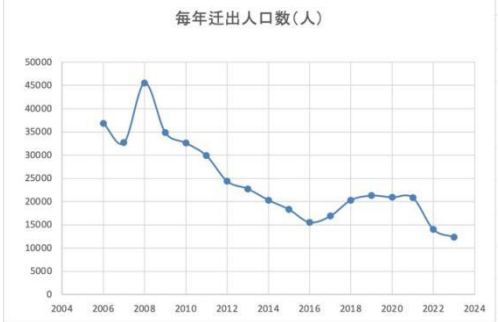
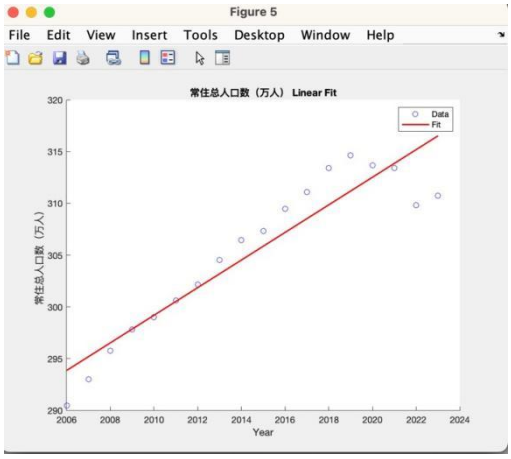
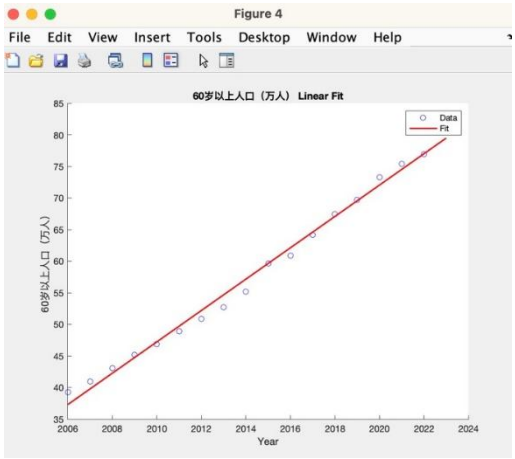


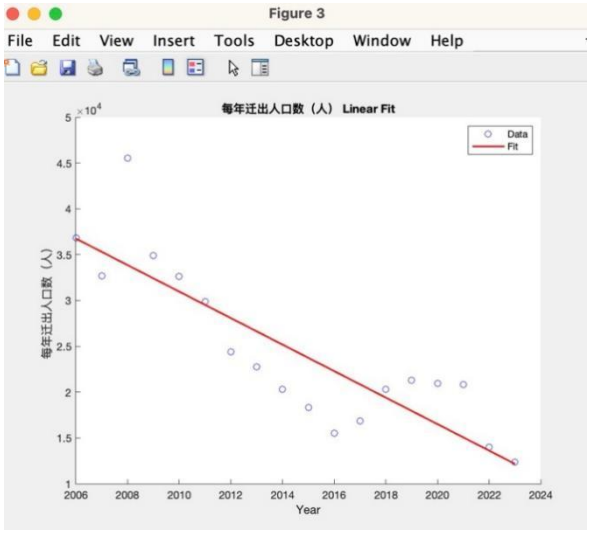
Figure 2.1 Population statistics of Qinhuangdao City

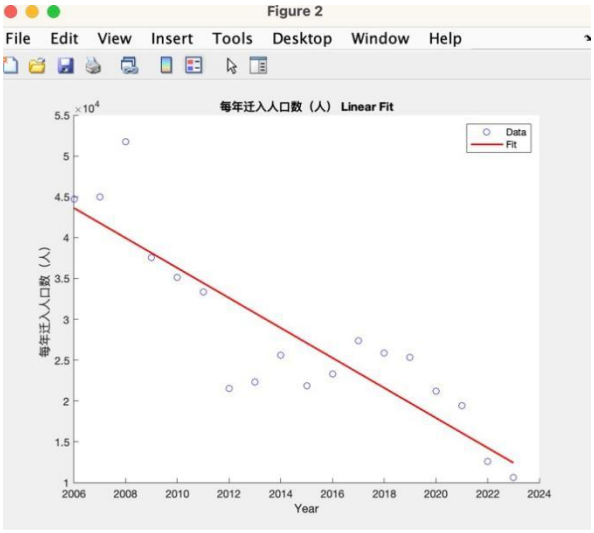
Through the graphs, this study found that all the data generally show linear or exponential relationships. For example, the population aged 60 and above shows a clear linear growth trend. Although the annual birth population fluctuates, it also shows a year-by-year decreasing trend after 2017. The total resident population showed an increasing trend from 2006 to 2019, but there was a turning point and a decreasing trend from 2019 to 2022. It then began to increase again. Based on the social situation in recent years, it is preliminarily speculated that the decrease in population starting in 2019 was due to the pandemic.

Then Matlab was used as a tool to do linear regression analysis for the above five groups of data, and through least square fitting, it was found that the data as a whole could present a good linear relationship. The fitting results and images are shown in Figure 2.2.









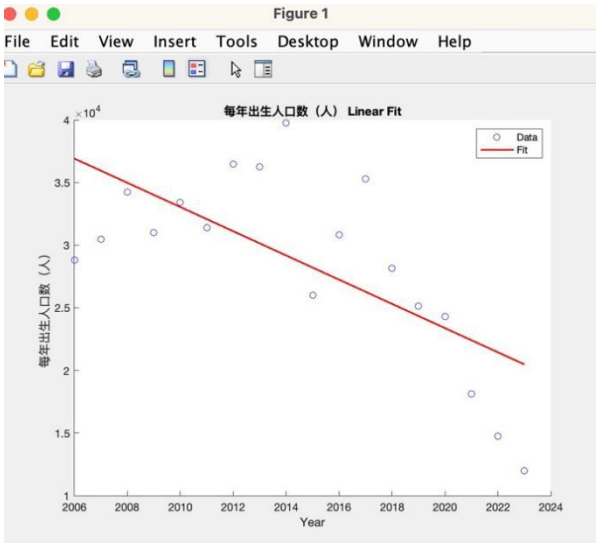


Figure 2.2 Linear fitting results

The calculation results are as follows: the slope of the annual birth population versus the year is -966.6914; the slope of the annual in-migrant population versus the year is -1835.4912; the slope of the annual out-migrant population versus the year is -1445.8566; the slope of the population aged 60 and above versus the year is 2.4810; the slope of the total resident population versus the year is 1.3333.

3. Elderly care industry planning based on the least squares method

As of 2023, statistics show that Qinhuangdao City has approximately 51 elderly care institutions, providing about 9,306 beds. The city is home to 3,823 medical and health institutions, including 92 hospitals, 75 township health centers, 133 community health service centers, and 8 maternal and child health hospitals, with a total of 23,800 actual beds available. Based on the slope of the fitted line and initial data, it is projected that the population aged 60 and above will reach 931,250 in five years. In terms of elderly care beds, the ratio of elderly care beds to the population aged 60 and above in Qinhuangdao in 2023 is about 9,306/807,200=0.0115. Assuming this ratio remains constant over the next five years and considering the growth of the elderly population, it is predicted that the city will need 10,709 elderly care beds in five years, which means an additional 1,403 beds will be required.

Regarding medical beds, the ratio of medical beds to the population aged 60 and above in Qinhuangdao in 2023 is approximately 23,800/807,200=0.0295. To maintain the current match between the elderly care industry and the elderly population in five years, it is projected that the city will need 27,472 medical beds in five years, which means an increase of 3,672 medical beds will be needed. However, Qinhuangdao City is currently still facing the problem of insufficient elderly care and medical beds. Therefore, within the next five years, the increase in elderly care beds needed in Qinhuangdao City will exceed 1,403, and the increase in medical beds will also exceed 3,672. This calls for the government and relevant industry departments to adjust policies or operational models to meet the growing demand for elderly care services from the increasing elderly population.

Drawing on the improvement experiences of other cities and countries, the government of Qinhuangdao City can take the following measures: First, the government should continue to increase the financial budget for elderly care services, allocating the budget specifically for the construction of elderly care beds and facility upgrades. The government can also reduce the operating costs of elderly care institutions through tax exemptions and preferential administrative fee policies, effectively encouraging them to increase bed supply.

In the case of insufficient external elderly care institution beds, the government and relevant departments should actively promote the construction of intelligent family elderly care beds. For elderly people with limited mobility, age-friendly renovations and the installation of smart devices can be carried out to introduce professional equipment and medical devices into the homes of the elderly. For example, Shanghai has promoted the standardized development of family care beds, aiming to add 8,000 service recipients by 2025. In addition, establishing elderly care service centers in communities to provide additional beds, medical care, health consultation, and other services can also effectively alleviate the shortage of beds.

For enterprises related to elderly care services, a variety of effective improvement solutions can be proposed according to the actual situation. For example, enterprises can flexibly utilize idle resources, such as transforming idle factories, schools, and office buildings into elderly care facilities if conditions permit. By guiding the construction of elderly care institutions in cooperation with medical and health institutions and communities, or by setting up medical service institutions within elderly care institutions, the supply of integrated medical and elderly care beds can be increased, thereby converting some medical beds into elderly care beds. This will significantly alleviate the shortage of beds and allow more elderly people to enjoy social security services.

With the continuous advancement of technology and the increasing maturity of artificial intelligence technology, introducing artificial intelligence technology into the elderly care industry may improve efficiency and achieve more significant results. For example, developing intelligent bed management systems using AI technology can enable real-time monitoring of bed usage and the health data of the elderly. Elderly care institutions can use data analysis to accurately grasp bed demand and understand the living and treatment preferences of the elderly, thereby reasonably arranging beds and improving bed utilization. For example, when the system predicts that beds in a certain area are tight, resources can be reallocated in advance or the elderly can be guided to choose other suitable elderly care institutions to avoid the situation where the elderly cannot receive elderly care services due to a shortage of beds. In addition, remote medical services can be carried out through AI technology, allowing the elderly to receive diagnoses and treatment recommendations from professional doctors at home or in elderly care institutions. Online nursing platforms can also enable nursing staff to remotely guide family members in providing care or offer remote nursing services for the elderly, effectively increasing the supply of virtual elderly care beds.

4. Conclusion

In industrialized countries around the world, population aging is inevitable. Therefore, in order to fully cope with a series of challenges brought by the aging population, every country should improve or modify its policies according to its actual national conditions, and support and promote the development of the elderly care industry and medical service industry. At the same time, almost many countries will also face an increasing demand for medical and nursing care beds as the number of elderly people increases, never leading to a shortage of beds. In this case, the government should actively think about solutions, either expanding the number of beds in hospitals and elderly care institutions or making improvements and innovations to meet the needs of citizens.

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