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EMPIRICAL RESEARCH QUANTITATIVE

Forecast of the number of nursing beds per 1000 older people from 2023 to 2025: Empirical quantitative research

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Abstract

Aim: This research aims to offer a reference point for relevant departments to enhance the allocation of ageing resources and formulate policies accordingly.

Design: This study is designed as empirical quantitative research.

Methods: Data from the National Bureau of Statistics and the Ministry of Civil Affairs regarding older adults (aged≥60) from 2000 to 2022 and nursing beds from 1978 to 2022 were analysed. The differential autoregressive integrated moving averages model and Monte Carlo simulation were used to predict the growth of nursing beds per 1000 older people in China for the Years 2023–2025.

Results: It is projected that from 2023 to 2025, China will experience a further increase in its ageing population, with an average annual growth rate of 3.1%. By 2025, the number of older people in China is expected to surpass 300 million. Additionally, there will be a rise in the number of nursing beds, with an average annual growth rate of 1.9%, leading to a total of 8.79 million nursing beds by 2025. However, due to the rapid growth of the older population, there will be a slight decline in the number of nursing beds per 1000 older people in China, with an average annual growth rate of −1.00%.

KEYWORDS

Monte Carlo, nursing beds, older people, time series analysis

1 | INTRODUCTION

The Healthy China Initiative (2019–2030) has emphasised China's status as the country with the largest population of older citizens globally (National Health Commission of the People's Republic of China, 2019). In alignment with international standards, China transitioned to “mild ageing (refers to the natural, gradual changes in the body and mind that occur with advancing age without significant impairment. It encompasses subtle physical adjustments, minor cognitive shifts and slight decreases in energy levels that do not profoundly affect daily activities or overall well-being)” society, in 1999, witnessed continuous growth in its elderly population (National Information Center, 2016). According to the latest data released by the National Bureau of Statistics of China, the number of individuals aged 60 and above in China reached 280 million in 2022, constituting 19.8% of the total population. This signifies China's imminent entry into the phase of “moderate ageing (refers to the intermediate stage of the natural ageing process, where noticeable changes occur in the body and mind. This phase involves more pronounced physical adjustments, cognitive shifts and a moderate decline in energy levels)” (National Bureau of Statistics, 2023). Statistical projections indicate that the boomers born between 1946 and 1964 will enter the ageing stage within the next 5–10 years, intensifying the challenges of population ageing during the 14th Five-Year Plan period more than in the previous 13th Five-Year Plan period (Zhang et al., 2023).

In China, the availability of ageing care services has shown a consistent increase since 2013. The total number of nursing beds was 4.937 million in 2013, experiencing an annual growth rate of 5.8% over the past decade. By the end of 2022, the number of nursing beds had risen to 8.223 million (Ministry of Civil Affairs of the People's Republic of China, 2014; National Bureau of Statistics, 2023). Despite this growth, the number of nursing beds per 1000 older adults aged 60 and above remains relatively low due to the ageing population. As of 2022, there are only 29.4 nursing beds per 1000 older adults (National Bureau of Statistics, 2023). According to international standards, there is still a statistically significant shortage of nursing beds in China, as the recommended ratio is 50 beds per 1000 older adults.

With the continuous growth of China's older population, the demand for ageing care services is also escalating. The 14th Five-Year Policy Plan (14th FYP hereafter) sets a target of having over 9 million nursing beds by 2025 (The State Council of the People's Republic of China, 2021). Therefore, accurately forecasting the number of nursing beds is both theoretically significant and practically useful.

The objective of this study is to predict the number of nursing beds per 1000 older people. Firstly, based on historical data, the number of older adults (aged ≥60) and the number of nursing beds nationwide from 2023 to 2025 are predicted using differential autoregressive integrated moving averages (ARIMA). Secondly, the Monte Carlo simulation is employed to predict the number of nursing beds per 1000 older people in China from 2023 to 2025 based on the calculated population bed data. Finally, the amalgamated projected results will offer recommendations for China to proactively address the challenges of population ageing, focusing on the research problem and the study's rationale.

2 | BACKGROUND

Population ageing is a global challenge with profound implications for diverse facets of human society (Li & Yu, 2007). Initially observed in developed nations like the United States, Australia and much of Western Europe in the mid-20th century, ageing has since accelerated worldwide, with 71 countries transitioning to ageing societies by 2010. Although developing countries have experienced a more gradual ageing process, the number of older adults is rapidly rising (García-Lara et al., 2017; Moncatar et al., 2020). In China, the proportion of individuals over 65 rose from 7% in 2002 to over 11.4% in 2017 (National Bureau of Statistics of China, 2018), with projections suggesting a potential 30% by 2050 (National Bureau of Statistics of China, 2017). Africa, while witnessing a surge in its youth population, anticipates a substantial increase in older adults due to enhanced childhood survival and lower adult mortality, nearly doubling to 58 million in the next two decades (Population Division, Department of Economic and Social Affairs, United Nations, 2015). Despite these demographic shifts, these regions lack sufficient nursing beds to accommodate the ageing populace. In the context of ongoing population growth and escalating ageing trends, accurately forecasting the demand for elderly care beds and addressing associated challenges becomes paramount for individuals, businesses and governments. Both domestic and international research have leveraged time series methodologies, Monte Carlo simulation and machine learning to project the impact of population ageing on healthcare capacity. A study from the University of Oxford, UK, specifically employed Monte Carlo simulation to evaluate the implications of population ageing on healthcare institution bed demand within the country (Julius, 1995).

3 | MATERIALS AND METHODS

3.1 | Data source and processing methods

The elderly care bed data is sourced from publicly released data by the National Bureau of Statistics from 1987 to 2010 and official data annually released by the Ministry of Civil Affairs from 2011 to 2021. The population aged 60 and above is based on publicly reported data from the National Bureau of Statistics' 'China Statistical Yearbook.' The data type is discrete quantitative, presented as absolute values. Data extraction was conducted using Excel 2021, and statistical analysis, including time-series analysis and Monte Carlo simulation, was performed using R 4.3.0.

3.2 | Research methods

3.2.1 | ARIMA model

We utilised a time series method to analyse the number of older people and nursing beds, and then, construct nonseasonal ARIMA models for each. The ARIMA model is abbreviated as ARIMA(*p*, *d*, *q*), where *p*, *d* and *q* stand for the autoregressive order, the non-seasonal differencing degree, and the moving average order, respectively. The overall format of ARIMA(*p*, *d*, *q*) can be outlined as follows:

$$\begin{cases} \Phi(B)\Delta^d x_t = \theta(B)\varepsilon_t \\ E(\varepsilon_t)=0, \mathrm{Var}\left(=\sigma_\varepsilon^2, E(\varepsilon_t,\varepsilon_s)\right)=0, s\neq t \\ E(x_s,\varepsilon_t)=0, \forall s<t. \end{cases}$$

In the equation, $\Delta^d x_t$ is the d-order differential post-sequence, $\Delta^d=(1-B)^d$, B is the delay operator, $\Phi(B) = 1-\phi_1 B-\phi_2 B^2- \dots -\phi_p B^p$ is the autoregressive coefficient polynomial for the stationary reversible ARMA(*p*, *q*) model; $\theta(B) = 1+\theta_1 B+\theta_2 B^2+ \dots +\theta_q B^q$ is the moving smoothing coefficient polynomial for stationary and reversible ARMA(*p*, *q*). $\{\varepsilon_t\}$ is a zero mean white noise sequence (Box & Jenkins, 1970).

3.2.2 | Monte Carlo simulation

This study utilised the Monte Carlo simulation method, which involves using random numbers for calculations (James, 1980). The results of the ARIMA model were used to conduct 10,000 Monte Carlo simulations for the years 2023–2025, focusing on older people and nursing beds. Through this process, the mean value and 95% confidence interval of the number of nursing beds per 1000 older people were determined.

3.3 | Statistical analysis

To construct ARIMA(p, d, q), four main steps were followed (Box & Jenkins, 1970; Jiménez et al., 2007; Mao et al., 2022; Tsay, 2005; Wang, 2015):

1. Data pre-processing

The initial step involved data pre-processing, comprising two main aspects: the stationarity test and the white noise test. Firstly, the overall trend and pattern of the data were qualitatively observed through a sequence diagram. Subsequently, the Augmented Dickey-Fuller (ADF) test was employed to verify the stationarity of the series. If the time series proved non-stationary, data differencing was iteratively performed until achieving stationarity. Post-differencing, the Ljung-Box test was applied to determine whether the stationary time series belonged to the white noise series, as the latter is not conducive for further analysis. If the data belonged to stationary non-white noise series, the process proceeded to model fitting.

2. Model identification

For model identification, the preliminary ordering of model parameters was initiated based on autocorrelation or partial correlation plots. Subsequently, a grid search was employed to select the optimal model with the lowest Akaike's information criterion (AIC) value.

3. Significance testing

The third step involved conducting significance testing on the model. The Ljung-Box test was utilised to examine the residuals of the optimal model. If the model was reasonably constructed, the residuals should exhibit characteristics of white noise.

4. Model validation and prediction

Finally, model validation and prediction were carried out by comparing the fitted data of the ARIMA model with the original data. The fitting effect was assessed using the mean absolute scaled error (MASE) indicator. Once model validation was completed, the ARIMA model could be employed for short-term forecasting. The linear minimum variance prediction method, commonly used for stationary sequences, was applied. This method minimises the variance of prediction errors by selecting the optimal linear combination coefficient. Given past observations, the weight of the linear combination was adjusted to minimise the difference between the predicted and actual observations. Refer to Figure 1 for the flowchart.

For data collation, Excel 2021 was utilised, while modelling, analysis and prediction were performed using R 4.3.0. A statistically significant difference was indicated by $p < 0.05$.

4 | RESULTS

4.1 | ARIMA model

4.1.1 | Stationarity test and time series smoothing processing

The original sequence diagram shows a statistically significant increasing trend of older people in China during 2000–2022 (Figure 2), and the ADF test is not statistically significant ($p = 0.357$), indicating that the series is non-stationary (Table 1). To rectify this, differential processing of the original sequence is necessary. Upon conducting second-order difference, the sequence diagram shows that the sequence has become a stationary time series (Figure 2), and both the ADF test and Ljung-Box test are important ($p < 0.05$) (Tables 1 and 2), indicating the successful elimination of the original sequence trend. Thus, the proposed parameter d in the ARIMA(p, d, q) model is 2.

Similarly, the number of nursing beds in China has seen a general increase from 1978 to 2022 (Figure 2), and the ADF test shows that the original sequence is non-stationary (Table 1). After the second-order difference, a stationary sequence is obtained, but the Ljung-Box test is not important ($p = 0.297$) (Table 2), suggesting that further differencing is required. Upon conducting third-order difference, both the ADF test and Ljung-Box test are important ($p < 0.05$) (Tables 1 and 2). Thus, parameter d in the ARIMA(p, d, q) model is proposed as 3.

4.1.2 | Model identification

Figure 3 displays the ACF and PACF plots of the older people after undergoing second-order differencing. The ACF plot indicates that all lags autocorrelation coefficients are within 2 times the standard deviation except for the 1st-lag, so $p \in \{0,1\}$; Meanwhile, the PACF plot shows that the partial correlation coefficients exhibit 1st-order truncation, which can be considered as $q \in \{0,1\}$. Following the grid search principle, we have selected the optimal model, which is ARIMA(*1,2,0*), with the lowest AIC value of 308.29.

Similarly, Figure 3 presents the ACF and PACF plots of nursing beds after undergoing third-order differences. The ACF plots

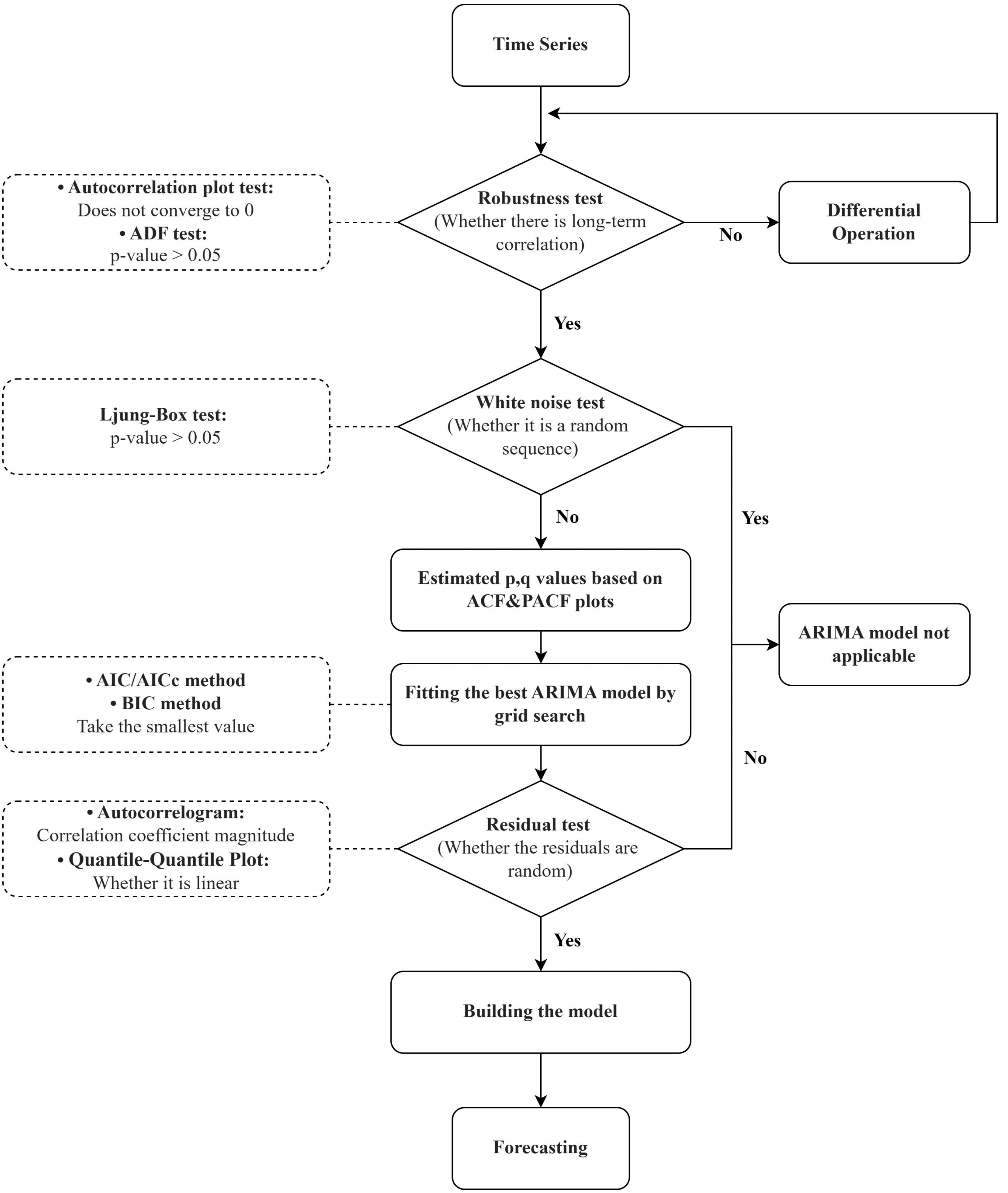

FIGURE 1 Flowchart of the time series analysis methodology. ACF, Autocorrelation Function; ADF, Augmented Dickey-Fuller; AIC, Akaike Information Criterion; AICc, Akaike Information Criterion with correction; ARIMA, Autoregressive Integrated Moving Average; BIC, Bayesian Information Criterion; PACF, Partial Autocorrelation Function.

demonstrate that the autocorrelation coefficients of all lags are within 2 times the standard deviation, except for the 1st-lag, indicating $p \in \{0,1\}$; The PACF plots reveal that the partial correlation coefficients exhibit 3rd-order truncation, leading to $q \in \{0,3\}$. Ultimately, ARIMA(*2,3,1*) is chosen as the optimal model because it has the smallest AIC value of 376.88.

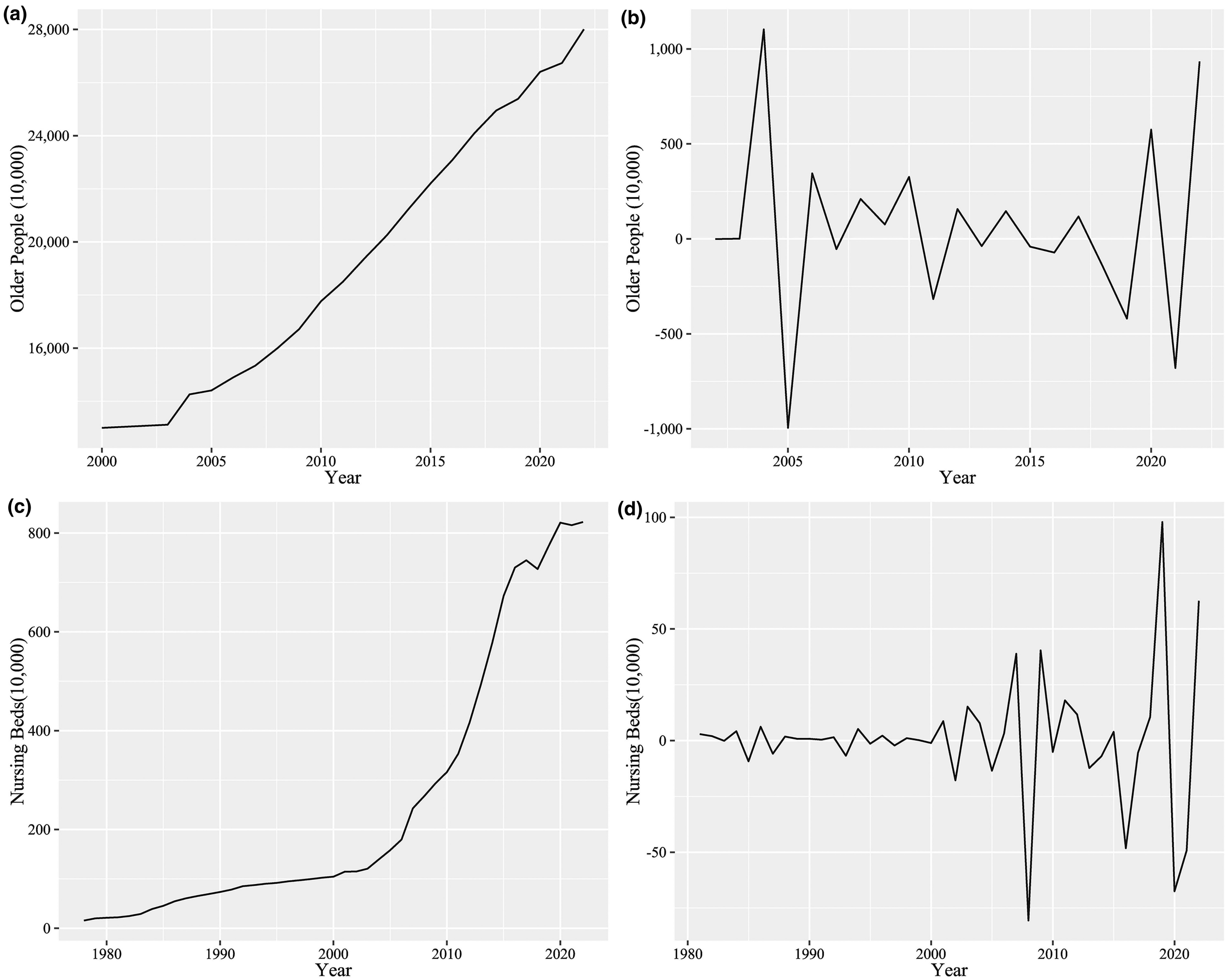

FIGURE 2 Original sequence diagram of older people (a); Second-order difference sequence diagram of older people (b); Original sequence diagram of nursing beds (c); Third-order difference sequence diagram of nursing beds (d).

TABLE 1 Unit root test results.

Parameter	Difference order	Augmented Dickey-Fuller test: Dickey-Fuller	*p*
Older people	Original	−2.564	0.357
	1st-order	−2.832	0.255
	2nd-order	−4.163	0.018
Nursing beds	Original	−1.443	0.795
	1st-order	−2.138	0.519
	2nd-order	−3.743	0.033
	3rd-order	−5.071	0.010

TABLE 2 White noise test results.

Parameter	Difference order	Ljung-Box test: Q_{LB}	*p*
Older people	Original	48.749	<0.001
	1st-order	4.211	0.240
	2nd-order	12.313	0.006
Nursing beds	Original	133.260	<0.001
	1st-order	46.037	<0.001
	2nd-order	4.907	0.297
	3rd-order	9.520	0.049

4.1.3 | Significance testing of the model

Based on Figure 4, it can be observed that the residual series of both the older people fitting model ARIMA(*1*,*2*,*0*) and the nursing beds fitting model ARIMA(*2*,*3*,*1*) are white noise series. Additionally, the results of the Ljung-Box test are not important ($P_{ARIMA(1,2,0)}=0.628$, $P_{ARIMA(2,3,1)}=0.892$), which suggests that the model structure is reasonable.

The mathematical expression of the ARIMA(*1*,*2*,*0*) is as follows:

$$\Delta^2 x_t = -0.729 x_{t-1} + \varepsilon_t$$

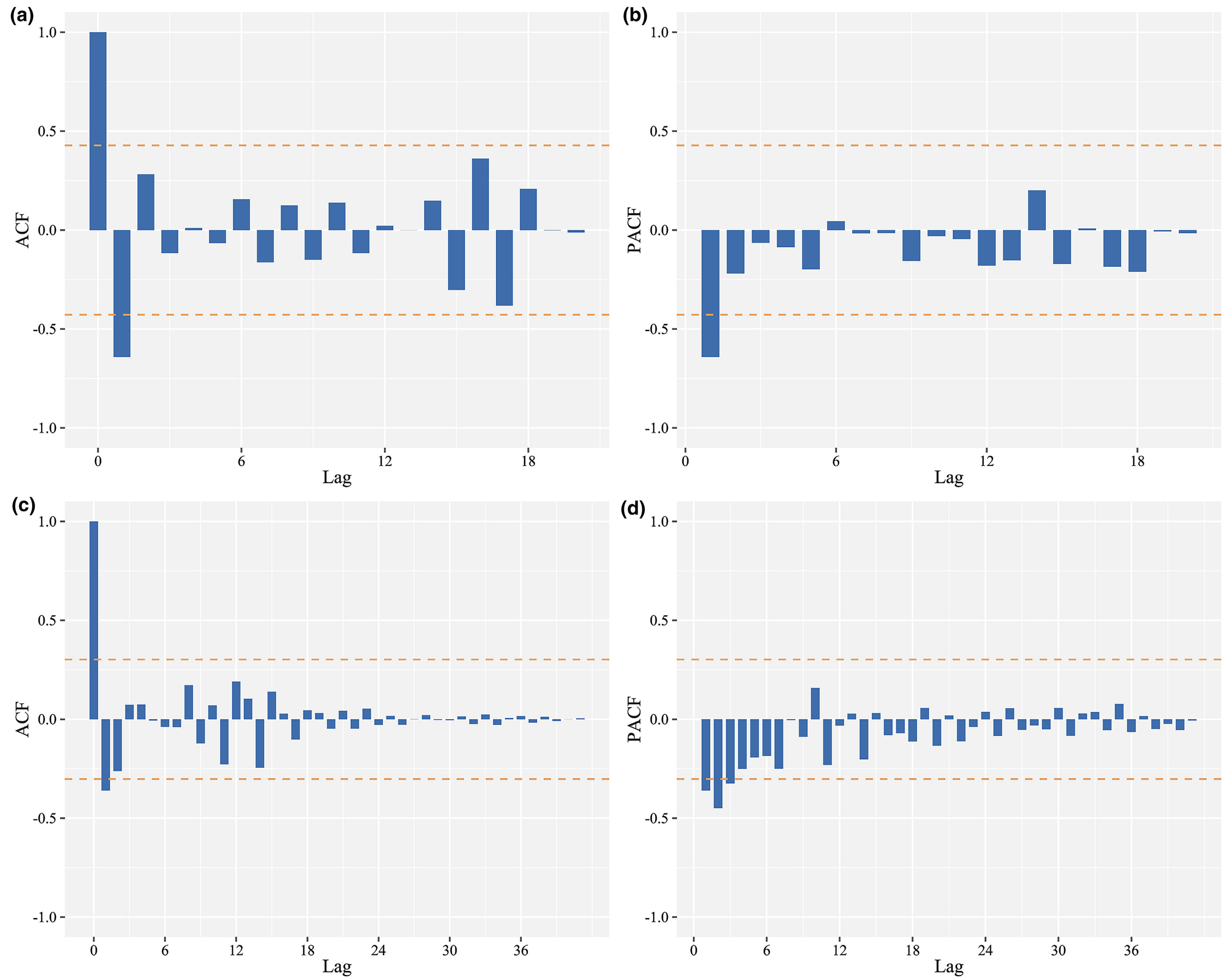

FIGURE 3 Autocorrelation function plots of the second-order differential sequences of older people (a); Partial autocorrelation function plots of the second-order differential sequences of older people (b); Autocorrelation function plots of the third-order differential sequences of nursing beds (c); Partial autocorrelation function plots of the third-order differential sequences of nursing beds (d). ACF, Autocorrelation Function; PACF, Partial Autocorrelation Function.

The mathematical expression of the ARIMA(*2*,*3*,*1*) is:

$$\Delta^3 x_t = -0.0512 x_{t-1} - 0.3421 x_{t-2} + \varepsilon_t + 1.000 \varepsilon_{t-1}$$

4.1.4 | Model validation and prediction

Based on the MASE values of the ARIMA(*1*,*2*,*0*) and ARIMA(*2*,*3*,*1*), it can be concluded that both models are highly reliable. These models were used to forecast the number of older people and nursing beds in China from 2023 to 2025, revealing that the number of older people in China will continue to increase in the coming years. It is projected that the number of older people in China will surpass 300 million by 2025, which is 1.4 times (95% CI: 1.3–1.6) the number in 2022. Additionally, the number of nursing beds is expected to gradually increase over the next 3 years, but at a relatively low average annual rate (3.1% vs. 1.9%). By the end of the 14th FYP, it is anticipated that the total number of nursing beds in China will reach 8.79 million. Figure 5 and Table 3 display the model fitting effect and prediction results.

4.2 | Monte Carlo simulation

Over the next 3 years, the quantity of nursing beds per 1000 older people in China is projected to decrease by −1.00% annually. By 2025, it is anticipated that there will be roughly 29.0 (95% CI: 23.0–35.7) beds per 1000 older people, as shown in Table 4.

5 | DISCUSSION

This study utilised population economics theory to establish an ARIMA time series model based on China's older population data from 2000 to 2022. It predicted the number of older people in

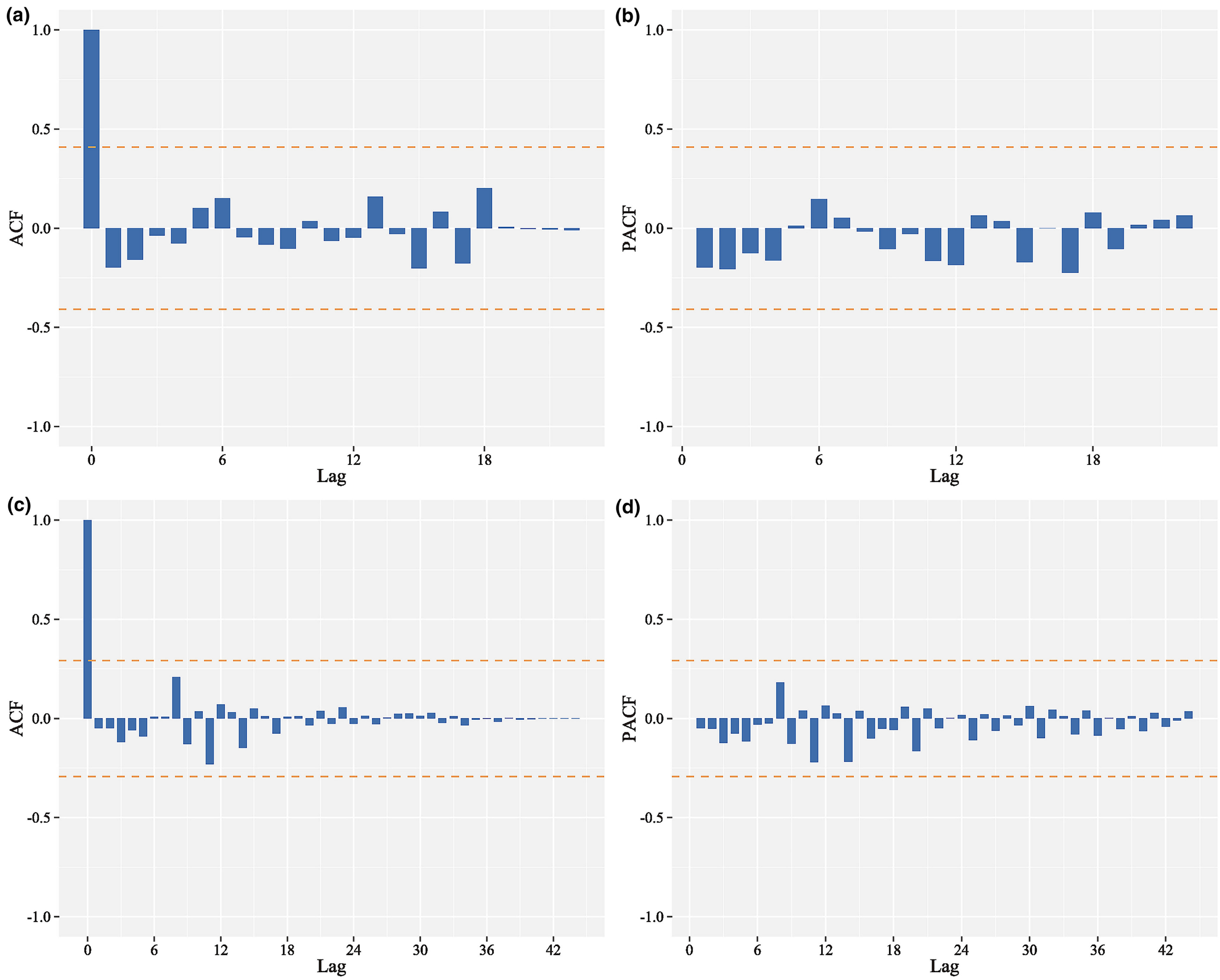

FIGURE 4 The test of ARIMA(*1,2,0*) residual error in older people by ACF (a); The test of ARIMA(*1,2,0*) residual error in older people by PACF (b); The test of ARIMA(*2,3,1*) residual error in the nursing beds by ACF (c); The test of ARIMA(*2,3,1*) residual error in the nursing beds by PACF (d). ACF, Autocorrelation Function; PACF, Partial Autocorrelation Function.

China over the next 3 years. The study's results indicate that by the end of the 14th FYP, China's population of individuals aged 60 and above will exceed 300 million, aligning with the National Health Commission's calculations. The issue of population ageing has placed significant pressure on China's economy, welfare and social security system. The increasing number of older individuals highlights the growing demand for old-age care. However, the current number of old-age care institutions, caregiver quality and services provided in China cannot satisfy their diverse care needs (Qing, 2016). As such, it is crucial to develop an integrated old-age care service system capable of meeting the health and social needs of older adults for China's future development.

Combined with the original sequence diagram in Figure 2, the development of China's ageing population, the construction history of the ageing care service system, and relevant policies, the growth of nursing beds in China can be categorised into four stages. The initial stage occurred between 1978 and 2000, with a slow, steady increase in the number of nursing beds for older adults. During this period, the social services for older individuals were inadequate, and nursing homes or sanatoriums were the main service providers. The government allocated limited resources for those with difficulties and special circumstances to solve some problems (Guo, 2019). The second stage was from 2001 to 2010, when the Party and government began to acknowledge the population's ageing trend and social demand, giving importance to the pension service system's construction. Since the beginning of the 21st century, there has been a statistically significant increase in nursing beds with the onset of a “mildly ageing” society (Guo, 2019); Between 2011 and 2017, the third stage saw a rapid increase in the number of nursing beds. China responded to the severe ageing and advanced ageing of the population and accelerated the development of an ageing care service system since 2011. In 2013, The State Council of the People's Republic of China issued Several Opinions on Accelerating the Development of

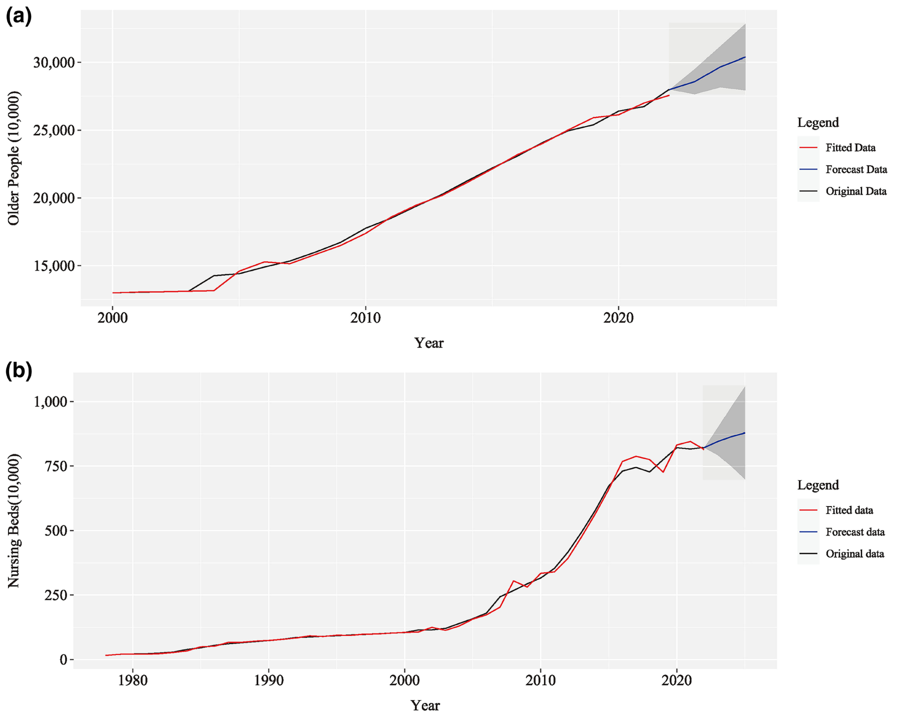

FIGURE 5 Forecast of the older people in China from 2000 to 2030 (a); Forecast of the nursing beds in China from 1978 to 2030 (b).

TABLE 3 Forecast result of ARIMA in China from 2023 to 2025.

Parameter	Estimate	SE	95%CI LL	95%CI UL
Older people (10,000)[a]				
2023	28,591	0.016	27,656	29,526
2024	29,675	0.025	28,163	31,186
2025	30,396	0.041	27,939	32,854
Nursing beds (10,000)[b]				
2023	846	0.031	793	899
2024	865	0.067	749	981
2025	879	0.104	699	1060

Abbreviations: CI, confidence interval; LL, lower limit; SE, standard error; UL, upper limit.

[a]ARIMA(*1,2,0*).

[b]ARIMA(*2,3,1*).

TABLE 4 Forecast of nursing beds per 1000 older people in China from 2023 to 2025.

Parameter	Estimate	SE	95%CI LL	95%CI UL
Nursing Beds per 1000 Older People				
2023	29.6	0.035	27.6	31.7
2024	29.2	0.071	25.2	33.5
2025	29.0	0.110	23.0	35.7

Abbreviations: CI, confidence interval; LL, lower limit; SE, standard error; UL, upper limit.

Ageing Care Services (The State Council of the People's Republic of China, 2013), which put forward the concept of "integrated care". The approach is tailored to the unique needs of senior citizens, combining financial and medical resources to deliver comprehensive healthcare services that prioritise basic life care. The document marked a milestone in the development of the pension service industry and originated the guiding policy and policy of the integration of medical and nursing care. In the following 5 years, the number of beds for the aged increased at an average annual rate of 10.8%. The last phase was 2018–2022 when the number of nursing beds in China showed a fluctuating growth trend. During this period, relevant departments focused on adjusting and optimising ageing care facilities, aiming to comprehensively improve the quality of ageing care services and enhance the total supply to achieve a quantitative to qualitative leap (The State Council of the People's Republic of China, 2020, 2022).

According to the 14th FYP, China aims to have 9 million nursing beds by 2025 (The State Council of the People's Republic of China, 2021). Nevertheless, achieving the target outlined in this article may still face challenges based on the calculations provided. China's current economic development level and the growing ageing population make it difficult to solely rely on expanding the number of care institutions to increase the availability of nursing beds per 1000 older people. Addressing this requires innovative solutions such as integrating medical and ageing care and promoting the intelligent healthcare industry. The study predicts that China will encounter a shortage of nursing beds by 2025, with an annual increase in the shortfall, posing significant challenges for nursing practice. This expected scarcity implies a heightened demand for healthcare services for older individuals, resulting in an increased workload for nursing staff. The potential surge in patient volume may create difficulties in delivering quality and timely care. Furthermore, the shortage is likely to drive a shift toward community and home-based care models, prompting nursing practitioners to explore innovative approaches and reduce strain on hospital resources. To meet the rising demand, the integration of technology in patient monitoring, including telehealth, remote monitoring and smart healthcare solutions, becomes crucial. Enhanced interdisciplinary collaboration is essential as healthcare service demand rises, necessitating close cooperation among professionals to coordinate care comprehensively. The evolving healthcare landscape emphasises the ongoing importance of training and skill development for nursing practitioners, focusing on managing increased patient loads, effective technology use and seamless collaboration within interdisciplinary teams. Additionally, nursing professionals are encouraged to actively advocate for policy changes addressing the anticipated shortage of nursing beds by engaging with policymakers to highlight challenges, propose solutions and contribute to the development of policies that support the healthcare needs of an ageing population.

The implementation of the National Nursing Development Plan (2005–2010) in China has positively impacted the nursing workforce (Zhang et al., 2023). The number of registered nurses increased by 198,000 annually, with significant improvements in the number of nurses per 1000 population, the nurse-to-health professional ratio and the doctor–nurse ratio. Particularly, the number of registered nurses at the grassroots level increased by approximately 860,000 from 2005 to 2021, contributing to a 1.4% increase in the national proportion of registered nurses. The conclusion emphasises the substantial expansion of China's nursing human resources and the optimisation of resource allocation efficiency through the National Nursing Development Plan. The subsequent plans (2011–2015 and 2016–2020) continued the strategic initiatives from 2005 to 2010, further expanding the nursing workforce and optimising resource allocation. However, the results do not directly address the impact on the number of elderly care beds in China. While the increase in nursing personnel lays the foundation for improving elderly care services, the actual situation regarding bed numbers requires further attention. The growth in nursing staff may indicate a rising demand for beds and long-term care facilities, but specific figures and substantial changes in bed allocation are not extensively discussed in the study. Future research could focus on assessing the interrelation between the increase in nursing personnel and the availability of elderly care beds, ensuring a balanced and sufficient distribution of medical resources. Exploring the relationship between nursing staff training and the enhancement of elderly care quality could further elevate overall service standards. Given the continuous growth of the elderly population, attention should be directed toward devising efficient, quality, and accessible services at various levels of care.

To sum up, the results of this study are highly important in addressing China's growing older population and the shortage of nursing beds during the 14th Five-Year period. It highlights the need for government departments to focus on ageing care services and provides valuable insights into estimating the size of the ageing market, predicting the development of care services, and promoting social undertakings in older care.

Although this article provides valuable insights, it does have some limitations. Firstly, due to data accessibility, only information on older people in China from 2000 onwards was collected. Data from 2001 to 2002 was missing, so it had to be filled using linear interpolation (Wang, 2015). Additionally, data from years other than 2000, 2010 and 2020 was derived from population sampling surveys, which may have led to some sampling errors. Secondly, while the ARIMA model is advantageous in that it does not require introducing exogenous variables, the changing trend of nursing bed numbers is influenced by various factors such as population ageing, pension policies, economic development, social demand and technological innovation. Therefore, these factors may result in some errors in the forecast data presented in this article.

6 | CONCLUSION

This research analysed data on older individuals aged 60 and above, as well as the number of nursing beds in China. By utilising the ARIMA model, estimates were made to predict the number of older individuals and nursing beds in China from 2023 to 2025. The validation results indicate that the ARIMA model is effective in short-term predictions. The analysis of the predicted results suggests that China's population ageing will continue to deepen in the future. However, due to China's faster population ageing rate compared to the growth rate of nursing beds, it is expected that by 2025, there will not be enough nursing beds to meet the 9 million required by the 14th FYP. Moreover, the gap in nursing beds in China will continue to increase yearly, according to the international standard of "50 beds per 1,000 older people." This prediction and analysis, based on the ARIMA model and Monte Carlo simulation, can assist decision-makers in clarifying policy formulation and construction priorities.

AUTHOR CONTRIBUTIONS

Ping Luo: Conceptualization, Methodology, Data Curation, Validation, Formal analysis, Writing-Original Draft, Writing – Review & Editing. **Lan Chen:** Methodology, Data Curation, Validation. **Yangwu Liu:** Conceptualization, Methodology, Data Curation. **Sheng Weng:** Project Administration, Supervision, Writing – Review & Editing.

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CONFLICT OF INTEREST STATEMENT

Authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is not available.

ETHICS STATEMENT

This study draws upon publicly available data sourced from the official website of a national government department, employing modelling techniques for predictive analysis. No individual patient data or information was collected during the research process. The study meticulously adhered to ethical standards in scientific research, encompassing the protection of personal privacy, adherence to data usage regulations and respect for intellectual property rights.

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REFERENCES

Box, G. E., & Jenkins, G. M. (1970). *Time series analysis: Forecasting and control*. Holden Day.

García-Lara, J. M. A., Navarrete-Reyes, A. P., Medina-Méndez, R., Aguilar-Navarro, S. G., & Avila-Funes, J. A. (2017). Successful aging, a new challenge for developing countries: The Coyoacán cohort. *The Journal of Nutrition, Health & Aging*, *21*(2), 215–219.

Guo, L. (2019). Elderly Services in China (1949–2019): Evolution, policy evaluation and prospect. *Chinese Social Security Review*, *3*(3), 48–64.

James, F. (1980). Monte Carlo theory and practice. *Reports on Progress in Physics*, *43*(9), 1145–1189.

Jiménez, Á. B., Lázaro, J. L., & Dorronsoro, J. R. (2007). Finding optimal model parameters by discrete grid search. In E. Corchado, J. M. Corchado, & A. Abraham (Eds.), *Innovations in hybrid intelligent systems* (Vol. *44*, pp. 120–127). Springer. https://doi.org/10.1007/978-3-540-74972-1_17

Julius, W. (1995). The impact of ageing upon the need for medical beds: A Monte-Carlo simulation. *Journal of Public Health*, *17*, 290–296.

Li, J., & Yu, B. (2007). Review of researches on economic burden of disease. *Chinese Health Economics*, *11*, 72–74.

Mao, L., Huang, Y., Zhang, X., Li, S., & Huang, X. (2022). ARIMA model forecasting analysis of the prices of multiple vegetables under the impact of the COVID-19. *PLoS One*, *17*(7), e0271594 https://doi.org/10.1371/journal.pone.0271594.

Moncatar, T. R., Nakamura, K., Siongco, K. L., Rahman, M., & Seino, K. (2020). Prevalence and determinants of self-reported injuries among community-dwelling older adults in The Philippines: A 10-year pooled analysis. *International Journal of Environmental Research and Public Health*, *17*(12), 4372.

National Bureau of Statistics of China. (2017). *Statistical bulletin of national economic and social development of China in 2016 national bureau of statistics of China*. https://www.stats.gov.cn/xxgk/sjfb/tjgb2020/201708/t20170811_1768640.html

National Bureau of Statistics of China. (2018). *China Statistical Yearbook*. https://www.stats.gov.cn/sj/ndsj/2018/indexeh.htm

National Bureau of Statistics. (2023). *Statistical bulletin of the People's Republic of China on National Economic and Social Development in 2022*. http://www.stats.gov.cn/sj/zxfb/202302/t20230228_1919011.html

National Information Center. (2016). *The trend and impact of aging population in China*. http://www.sic.gov.cn/News/455/5900.htm

Population Division, Department of Economic and Social Affairs, United Nations. (2015). *World population prospects in: The 2019 revision. Key Findings and Advance Tables*. United Nations. http://www.demographics.at/structure.html

Qing, L. B. (2016). The current situation and prospects of the development of China's elderly care service industry. *Journal of Fujian Provincial Committee Party School of CPC (Fujian Academy of Governance)*, (3), 75–83.

The State Council of the People's Republic of China. (2013). *Several opinions of the state council on accelerating the development of the elderly care service industry*. https://www.gov.cn/zwgk/2013-09/13/content_2487704.htm

The State Council of the People's Republic of China. (2020). *Notice on carrying out actions to improve the service quality of medical and nursing institutions*. https://www.gov.cn/zhengce/zhengceku/2020-12/16/content_5569963.htm

The State Council of the People's Republic of China. (2021). *The notification for the "14th Five-Year Plan" national elderly care development and elderly care service system planning*. https://www.gov.cn/zhengce/content/2022-02/21/content_5674844.htm

The State Council of the People's Republic of China. (2022). *Guiding opinions on further promoting the development of the combination of medical care and elderly care*. https://www.gov.cn/zhengce/zhengceku/2022-07/22/content_5702161.htm

Tsay, R. S. (2005). *Analysis of financial time series*. John Wiley & Sons.

Wang, Y. (2015). *Time series analysis with R*. China Renmin University Press.

Zhang, W.-Q., Tang, W., Hu, F.-H., Jia, Y.-J., Ge, M.-W., Zhao, D.-Y., Shen, W.-Q., Zha, M.-L., & Chen, H.-L. (2023). Impact of the National Nursing Development Plan on nursing human resources in China: An interrupted time series analysis for 1978–2021. *International Journal of Nursing Studies*, *148*, 104612.

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