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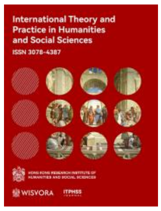

Forecasting Financial Expenditures for Long-Term Care Insurance: Evidence from the Typical Pilot Cities in China

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Abstract

Purpose: This study aims to provide decision-makers with a reference by predicting the financial expenditures and trends of long-term care insurance in China over the next thirty years.
Approach/Methodology/Design: This study employs Markov chains and overall simulation model to forecast the extent of financial expenditures on long-term care for employees and residents. It examines the financial outlay levels under various entitlement payment scenarios and estimates the discrepancies in financial expenditures between employees and residents from 2021 to 2050.
Findings: The results show that (1) The number of disabled elderly employees aged 60 and above will be about 14,288 thousand, and the number of disabled elderly residents will be about 68,176 thousand in 2050. (2) Under the low scenario, the financial expenditures of elderly employees and residents in 2050 will reach 29,636.87 million yuan and 17,597.92 million yuan respectively, which are 2.86 and 10.24 times as much as those in 2021. The total financial expenditures under the medium and high scenarios will be 2.38 and 5.51 times as much as those under the low scenario respectively. (3) The scale of financial expenditure on long-term care insurance for residents far exceeds that of employees, and the trend is expanding.
Practical Implications: This study may provide theoretical support for the full implementation of long-term care insurance policies.
Originality/value: This study uses Markov models and overall simulation models, along with typical representative plans from pilot areas in China, to differentiate the insurance identity of elderly employees and residents and to estimate the scale and trend of financial expenditures for long-term care insurance in China from 2021 to 2050.

1. Introduction

The global trend of population aging has a significant and enduring impact on human society (Fent, 2008). With the deepening of population aging, the demand for long term care (LTC) services among the elderly continues to increase (Kaschowitz & Brandt, 2017; Schulz et al., 2004). In 2000, China transitioned into an aging population society (Lu & Liu, 2019), the size of the elderly population base is large and the population is ageing rapidly(Werblow et al., 2007). Recent statistics indicate that the population of individuals aged 60 and older had approached nearly 280 million by the close of 2023(2022 National Development Bulletin on Aging, n.d.). The prolongation of life expectancy has resulted in a rising population of elderly individuals with disabilities(Deng & Li, 2019; Matthews et al., 2006), prompting a rapid escalation in the demand for elderly care(Y. Han et al., 2020; Metzelthin et al., 2017). Concurrently, the family structure has become smaller and traditional informal care at home is not effective in protecting the elderly with disabilities(Fan, 2007; Lakdawalla & Philipson, 2002). Consequently, LTC has emerged as a pressing social issue that demands attention. The government of China to study and learn from the experience of Germany(Campbell et al., 2010a), Japan and other countries in establishing a social insurance system for long-term care(Campbell et al., 2010b; Cuellar & Wiener, 2000; Tamiya et al., 2011). Beginning in 2016, long-term care insurance(LTCI) system is being built on a pilot basis in 49 regions. Differences in participation status are divided into employee and resident LTCI, applying different financing models, care service modes and treatment payment levels, coupled with differences in the demographic structure, degree of ageing and number of disabled people in each region, each pilot region faces a different degree of burden of financial expenditure on LTCI, posing a challenge to the sustainable operation of the LTCI system(Seok-Hwan et al., 2023; X. Zhang et al., 2021).

2. Literature Review

Most countries that have established the LTCI system to pay close attention to LTCI financial expenditures (Zogg, 2013)and financial sustainability issues(Emmanuele & Ranci, 2008; Wu et al., 2022). Most existing research focuses on several key areas. The criteria used to assess LTC needs and the number of the disabled elderly population are crucial elements that impact the computation of LTC expenses for older individuals. International researchers typically utilize the Activities of Daily Living scale(ADLs) and Instrumental Activities of Daily Living scale(IADLs) endorsed by the World Health Organization , along with the Global Activity Limitation Indicator(GALI), to assess the degree of disability among elderly individuals(Tinios & Valvis, 2023). In the beginning, international scholars constructed simulation models, Markov models, and PAC Sim models that consider the variations in the levels of disability among the elderly to forecast LTC expenditures for disabled seniors (Statistics of the National Medical Security Bureau Statistical Bulletin on the Development of National Medical Security in 2022, 2023). As the research advances, some scholars have initiated analyses concerning the long-term care expenditures associated with specific diseases, such as Dementia(E.-J. Han et al., 2021; Kawabata & Fukuda, 2023), Alzheimer's disease(Shin, 2016; Takechi et al., 2019), Parkinson's disease (Schmitz et al., 2022), among others. Numerous countries worldwide are currently encountering the issue of escalating LTC costs. In South Korea, the population of elderly individuals receiving informal care is projected to rise from 710,000 in 2020 to 2.2 million by 2067. The demand for informal care is anticipated to surge by 257% (Hu et al., 2022). In Australia, over the next three decades, there is expected to be a 70% increase in the number of elderly individuals with severe disabilities, resulting in a notable increase in the expenses associated with community-based elderly care services. Similarly, Germany is confronting challenges posed by a heightened demand for LTC, substantial financial commitments, and the risk of unsustainable LTCI systems (Geyer, 2020).

This paper aims to contribute to the existing research in the following four key areas: firstly, leveraging the population projection software PADIS-INT and the data from the 7th national population census to forecast the elderly population from 2021 to 2050. Secondly, employing data from the 2018 and 2020 CHARLS, in combination with disability assessment methodologies and

LTC implemented in pilot regions, to conduct discrete Markov chain analysis for monitoring transitions in health statuses and enhancing precision in predicting LTC needs(Da ROIT & Le BIHAN, 2010; Grabowski, 2006). Thirdly, differentiating between insured statuses to estimate the number of elderly employees and disabled residents, and evaluating variations in LTCI financial expenditures under diverse treatment and payment policies. Lastly, projecting the expenditure patterns and trends of China's LTCI financial from 2021 to 2050, based on typical plans implemented in pilot cities (Feder et al., 2018; Maarse & Jeurissen, 2016) .To provide a basis for establishing an efficient operating system and secure financial framework for the LTCI system.

3. Materials and Methods

3.1. Data

3.1.1. Population data

Population projection draws from the 7th national population census data and utilizes the population projection software PADIS-INT to estimate the total population of China and the elderly population aged 60 and above from 2021 to 2050. According to the pilot implementation of China's LTCI system, the insured individuals and premium rates for LTCI align with those of country's national basic medical insurance programs(Liu & Hu, 2022). The insured population is categorized into two main groups: employees and residents, with the resident group encompassing both urban and rural dwellers.

3.1.2. Health status transition data

The data regarding the proportion of individuals with disabilities and alterations in their health status were sourced from CHARLS conducted in 2018 and 2020. Utilizing the methodology commonly employed by both scholars both domestically and internationally(Fukunishi & Kobayashi, 2023), the assessment of disability levels was conducted using six indicators from the Katz ADLs, covering activities such as bathing, dressing, transferring from bed to chair, toileting, eating, and bowel control. These six indicators were classified into four categories: "difficult", "difficult but manageable", "requiring assistance", and "unable to perform". For detailed information on data selection, please consult Table 1. Based on the findings of scholarly research(Xu et al., 2024), the initial two levels were categorized as those not necessitating LTC services, while the latter two levels were classified as necessitating such services. A classification of disability severity was determined by the quantity of items requiring LTC services, with 1-2 items denoted as mild disability, 3-4 items as moderate disability, and 5-6 items as severe disability(Cuellar & Wiener, 2000).

The purpose of this study is to assess the likelihood of a change in disability status among the same elderly individuals over a two-year period. To achieve this, new participants in the 2020 CHARLS were excluded, and only those from the follow-up sample were retained(Stone & Harahan, 2010). Subsequent screening procedures were focused on individuals aged 60 and above, excluding employees and residents who did not meet this criterion. The data cleaning process was conducted using Stata 15.0 to remove missing data, resulting in a total of 9,358 valid samples. Among these samples, 12.92% comprised employees and 87.08% comprised residents.

Table 1 CHARLS (2018-2020) Data Selection

CHARLS 2018	CHARLS 2020

DB010（dressing）	DB001（dressing）
DB011（bathing）	DB003（bathing）
DB012（eating）	DB005（eating）
DB013（transferring from bed to chair）	DB007（transferring from bed to chair）
DB014（toileting）	DB009（toileting）
DB015（bowel control）	DB011（bowel control）

3.1.3. LTCI financial expenditure data

The data on LTCI financial expenditure is derived from the policies implemented of the pilot cities. Qiqihar, Nantong, and Tsingtao were chosen to cater to individuals with severe, moderate, and mild disabilities, which respectively correspond to low, medium and high levels of care scenario. Regarding the selection of nursing methods, the majority of initial pilot cities opted for a combination of services provided by medical institution, elderly institution, community and home (Cao & Xue, 2023). The payment standards associated with these three schemes are outlined in Table 2.

Table 2 The payment standards for low, medium and high scenario

Scenario	Disability	Identity	Community and home care		Elderly institution care		Medical institution care	
			Payment	Reimbursement	Payment	Reimbursement	Payment	Reimbursement
Low	Severe	Employees	20 yuan/day	50%	25 yuan/day	55%	30 yuan/day	60%
		Residents	20 yuan/day	50%	25 yuan/day	55%	30 yuan/day	60%
Medium	Severe	Employees	12 yuan/day	/	43 yuan/day	/	57 yuan/day	/
		Residents	12 yuan/day	/	43 yuan/day	/	57 yuan/day	/
	Moderate	Employees	8 yuan/day	/	30 yuan/day	/	40 yuan/day	/
		Residents	8 yuan/day	/	30 yuan/day	/	40 yuan/day	/
High	Severe	Employees	1540 yuan/mouth	90%	50 yuan/day	90%	50 yuan/day	90%

	Residents	1100 yuan/mouth	85%	35 yuan/day	85%	35 yuan/day	85%
Moderate	Employees	1100 yuan/mouth	90%	35 yuan/day	90%	35 yuan/day	90%
	Residents	660 yuan/mouth	85%	22 yuan/day	85%	22 yuan/day	85%
Mild	Employees	660 yuan/mouth	90%	22 yuan/day	90%	22 yuan/day	90%
	Residents	440 yuan/mouth	85%	15 yuan/day	85%	15 yuan/day	85%

Note: The data is aggregated from multiple pilot cities.

3.2. Methods

3.2.1. Markov Chain Models

Given the absence of the disability status database (Biessy, 2022; Y. Zhang & Wang, 2021) , this study builds upon the research of prior scholars and employs the Markov chain method to forecast the likelihood and demographic count of elderly individuals with disabilities across various identity categories from 2021 to 2050. This approach offers notable benefits in enhancing model precision and predictive performance.

Markov chain is defined as a sequence of stochastic variables, $X(\mathrm{n})$ denotes the state of the Markov chain at time n. $n \in N$, parameter set $N = \{0, 1, 2, \cdots\}$, state space $S = \{0, 1, 2, \cdots\}$. Markov processes exhibit memoryless characteristics as the probability distribution of future status X_{n+1} is solely contingent upon the current status $X(\mathrm{n})$. The transition from the current status to subsequent status is referred to as a status transition, often elucidated through a transition probability matrix(Cardoso et al., 2012).

This study categorizes elderly individuals into four distinct statuses: health status a, mild disability status b, moderate disability status c, and severe disability status d. The probability of transitioning from the disabled status i to the disabled status j, denoted as P_{ij}, serves as the Markov transition probability, $P_{ij} = P(X_{\mathrm{n+1}} = j \mid X_n = \mathrm{i}), i, j \in S$. The Markov transition probability matrix comprises the transition probabilities between all four statuses of elderly individuals(Dudel & Myrskylä, 2020). The matrix is presented in the following form:

$$P = \begin{pmatrix} P_{aa} & P_{ab} & P_{ac} & P_{ad} \\ P_{ba} & P_{bb} & P_{bc} & P_{bd} \\ P_{ca} & P_{cb} & P_{cc} & P_{cd} \\ P_{da} & P_{db} & P_{dc} & P_{dd} \end{pmatrix}$$

When each status is required to undergo multiple transitions, it is referred to as a k-step transition, with the corresponding matrix denoted as $P^{(k)}$. Based on the definition, it can be inferred that $P^{(k)} = P^{(\mathrm{k}-1)} \cdot P$, by deduction, it can be concluded that $P^{(k)} = P^k$, this signifies that the k-step

Markov transition probability matrix $P^{(k)}$ can be acquired by calculating the k-th power of the Markov transition probability matrix P.

The row vector $S^{(0)}$ symbolizes the initial probability distribution of distinct status within the elderly individuals, $S^{(0)}=\left[S_a^{(0)} \quad S_b^{(0)} \quad S_c^{(0)} \quad S_d^{(0)}\right]$, using the transition probability matrix, the row vector representing the probabilities of disability status among the elderly following a k-step transition can be computed, $S^{(k)}=S^{(0)}\cdot P^k$.

This paper sets the disability status matrix of the elderly in 2018 as the initial distribution, and the disability status matrix of the elderly in 2020 as the final distribution. Therefore, it is imperative to compute the transition probability and employ MATLAB programming to ascertain the P-value. Building upon existing literature (Cui, 2017; Mayhew et al., 2021), this paper introduces the concept of transition strength, defined as the derivative of the transition probability matrix with respect to time interval n, the equation is as follows:

$$\frac{dP_{ij}}{dn}=\lim_{\Delta n\to 0}\frac{P_{ij}\left(n+\Delta n\right)-P_{ij}\left(n\right)}{\Delta n} \tag{1}$$

Define the transition strength as $\frac{dP_{ij}}{dn}=q_{ij}$, the transition strength can be represented in matrix form as $Q=\left[q_{ij}\right]_{4\times 4}$, based on the Kolmogorov forward equation, it can be deduced that $P\left(n\right)=\mathrm{e}^{\int_{n0}^{n0+n}Q(n)dn}$, it can be understood that:

$$P\left(n\right)=e^{Q\times n} \tag{2}$$

The transition strength matrix, $Q=P$,can be computed by performing the inverse operation on matrix indices. The transition strength matrix can be acquired through the inverse operation of the matrix index, following the equation:

$$Q=\frac{\log\left(P\left(n\right)\right)}{n} \tag{3}$$

Based on Equation (3) and given $P(2)$, compute the transfer strength matrix Q. Utilize Equation (2) to calculate $P(1)$. Use MATLAB programming to conduct matrix logarithmic and exponential operations.

3.2.2 LTCI Financial Expenditure Model

The LTCI financial expenditure model is impacted by factors such as the size of the disabled population, the severity of disabilities, the selection of nursing methods, and the payment ratio. Drawing on previous scholarly contributions, and given that LTCI is currently in a pilot phase with limited publicly available data, as well as varying benefit levels across these pilot cities, an overall simulation model is adopted to forecast LTCI financial expenditures.

The forecasting equation for the quantity of elderly individuals with diverse disabilities is represented by:

$$D_n^g=\sum_{h=1}^{3}l_n^g\times R_n^{gh} \tag{4}$$

The variable D_n^g denotes the quantity of elderly individuals with disabilities in the nth year, where the identity factor is designated by g. Here, $g=1$ signifies employees and $g=2$ refers to residents. The variable l_n^g denotes the quantity of elderly individuals with disabilities in the nth year according to identity g. The variable R_n^{gh} corresponds to the disability rate in the nth year, categorized by identity g and the severity level h of disability, where $h=1$ indicates mild disability, $h=2$ indicates moderate disability, and $h=3$ indicates severe disability. The equation for the annual expenditure of the LTCI financial is expressed as:

$$Y_h^{gz} = \sum_{m=1}^{3} y_{mh}^{gz} \times f_{mh}^{gz} \times r_m \quad (5)$$

The variable Y_h^{gz} represents the annual financial expenditure based on identity g, severity of disability h, and scenario z, where $z=1$ denoting the low scenario, $z=2$ denoting the medium scenario, and $z=3$ denoting the high scenario. The variable y_{mh}^{gz} signifies the financial expenditure towards identity g, severity of disability h, scenario z, and nursing methods m. In this context, $m=1$ denotes community and home care, $m=2$ signifies elderly institution care, and $m=3$ indicates medical institution care. f_{mh}^{gz} represents the payment ratio for different nursing methods. r_m represents the proportion of various nursing methods.

Based on Equation (4) and (5), using the Consumer Price Index (CPI) data provided by the National Bureau of Statistics of China ranging from 2013 to 2023, the inflation rate (denoted as 'u') is calculated at 1.76%. Therefore, the equation for calculating the total expenditure of the LTCI financial in the nth year is expressed as:

$$T_h^z = \sum_{g=1}^{2} Y_h^{gz} \times D_n^g \times (1+u)^n \quad (6)$$

4. Results and Discussion

4.1. Population forecast results

Table 3 presents the age-specific population distribution from 2021 to 2050. Figures 1(a) and (b) indicate that the population of China is projected to peak at approximately 1.413 billion in 2025, with a subsequent gradual decline expected. By 2050, the population is forecasted to reduce to 1.358 billion. In contrast to the general population trend, the demographic of individuals aged 60 and above is continually growing, reaching an estimated 558 million by 2050, representing 41.1% of the total population.

Table 4 provides a population projection for employees and residents aged 60 and above who are enrolled in LTCI over the period from 2021 to 2050. As outlined in Figure 1(c), the quantity of elderly individuals engaging in LTCI is anticipated to continuously escalate between 2021 and 2050, experiencing a more than twofold increase. Specifically, while the figure for elderly employees is anticipated to stabilize at a certain threshold, a marginal decline is expected post-2040. The extrapolated population size for 2050 is projected at 86 million individuals, concurrently, there will be a swift escalation in the count of elderly residents, displaying an average growth rate of 17.05% every five years. By the year 2050, this count is projected to reach 472 million, with the number of elderly residents surpassing that of elderly employees by a magnitude of 5.5.

Table 3 Population Forecast (Unit: Thousand)

Year	Total population	Years Old

		60-64	65-69	70-74	75-79	Over 80
2021	1,410,793	78,306	72,764	53,095	33,409	35,801
2025	1,412,878	98,014	69,259	66,941	41,648	40,862
2030	1,412,307	115,430	93,383	63,586	57,697	54,207
2035	1,408,083	108,434	110,873	86,941	56,041	78,181
2040	1,398,283	88,449	104,878	104,451	78,195	95,808
2045	1,380,883	94,673	86,057	99,791	95,553	128,779
2050	1,357,816	119,360	92,578	82,590	92,615	170,859

Table 4 LTCI Population Forecast (Unit: Thousand)

Year	Total population	Employees	Residents
2021	275,026	89,219	185,806
2025	316,724	89,351	227,373
2030	384,302	89,315	294,987
2035	440,470	89,048	351,422
2040	471,781	88,428	383,353
2045	504,852	87,328	417,525
2050	558,001	85,869	472,132

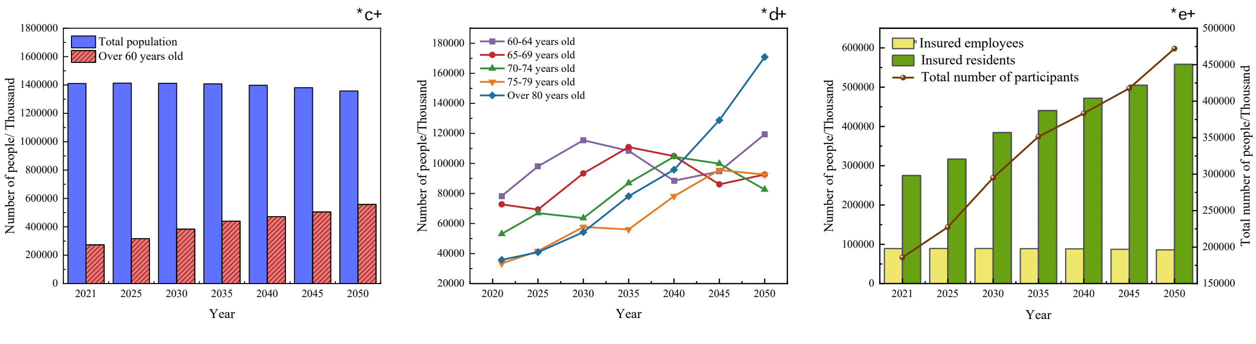

Figure 1 Population Forecast

4.2. Result of disability situation

By analyzing the CHARLS data for the years 2018 and 2020, we determined the probability of disability status for employees and residents aged 60 and above, as illustrated in Table 5, and compiled the probability matrix $P_n(2)$, detailing health status transitions spanning from 2018 to 2020. Employ MATLAB programming to convert the probability matrix $P_n(2)$ to $P_n(1)$ (As shown in Figure 2). Utilizing the findings from Table 5, utilize MATLAB software to compute the health status transition matrix $P_n(X)$ for elderly employees and residents spanning an X-year period (2021-2050), as demonstrated in Figure 3 (a) and (b). Establish Table 5 as the initial period population vector $S^{(0)}$, and utilizing the population projections from Table 4, compute the population count of employees and residents aged 60 and above covered by LTCI across various health status from 2021 to 2050, as depicted in Figure 3 (c) and (d).

Table 5 reveals that between 2018 and 2020, the health rates of elderly employees and residents exhibited an upward trajectory, concomitant with a decline in the likelihood of disability. In general, the health status of employees appears to outstrip that of residents. Figures 2 (a) and (b) suggest that elderly individuals with health are predisposed to maintaining their current status, whereas individuals with disabilities are more prone to deteriorating conditions(R. A. Kane, 2001). Significant disparities are evident in the health status transitions between disabled employees and residents. For those with mild disability, the probabilities of recovery for employees and residents stand at 30.75% and 14.42%. When confronted with moderate disability, employees face a 13.43% chance of progressing to severe disability, significantly higher than the 31.92% observed among residents. For individuals with severe disabilities, employees have a 35.78% chance of experiencing an improvement in their condition and a 12.26% chance of full recovery, while residents have a significantly lower chance of enhancing their condition at 24.27%, with almost no possibility of full recovery. This observation indicates that employees are more inclined to experience improvement when facing disabilities, whereas residents are more susceptible to health deterioration(Pawlson & Mourey, 1990). This distinction can be attributed to the comparative advantages that employees possess, such as lifestyle, work environment, social support, and access to medical resources, enabling them to recover more efficiently from disabilities and uphold a higher level of health, and people with disabilities are more prone to deteriorating conditions.

Figures 3 (a) and (b) depict the progression of health status among employees and residents spanning the years 2021 to 2050. Initially, residents exhibit a better condition in comparison to employees; however, with the passage of time, both groups experience a gradual decline in overall health status. The percentage of employees with health decreased from 89% to 83%, while residents saw a decrease from 91% to 86%. Hence, during the elderly phase, it is imperative to prioritize health management, disease prevention, and rehabilitative care in order to mitigate the onset of disabilities.

As shown in Figures 3 (c) and 3(d), the count of elderly employees in health is progressively diminishing, having decreased from 79.3 million in 2021 to 71.56 million in 2050, the number of individuals with mild disability has exhibited a gradual reduction, while those with moderate and severe disability have maintained a relatively steady level. In contrast, the elderly resident population continues to show consistent growth, with their numbers significantly surpassing those of the employee cohort. Hence, in the context of future policy formulation, priority should be given to addressing the health status of residents, with a focus on health education, optimized distribution of medical resources, aimed at enhancing the overall health status of the population and diminishing the prevalence of disabilities.

Table 5 Probability of Health Status of Elderly Employees and Residents

Status	2018		2020	
	Employees	Residents	Employees	Residents
Health	0.8958	0.8637	0.9333	0.8966
Mild disability	0.0687	0.1000	0.0379	0.0684

Moderate disability	0.0149	0.0197	0.0124	0.0161
Severe disability	0.0207	0.0166	0.0164	0.0189

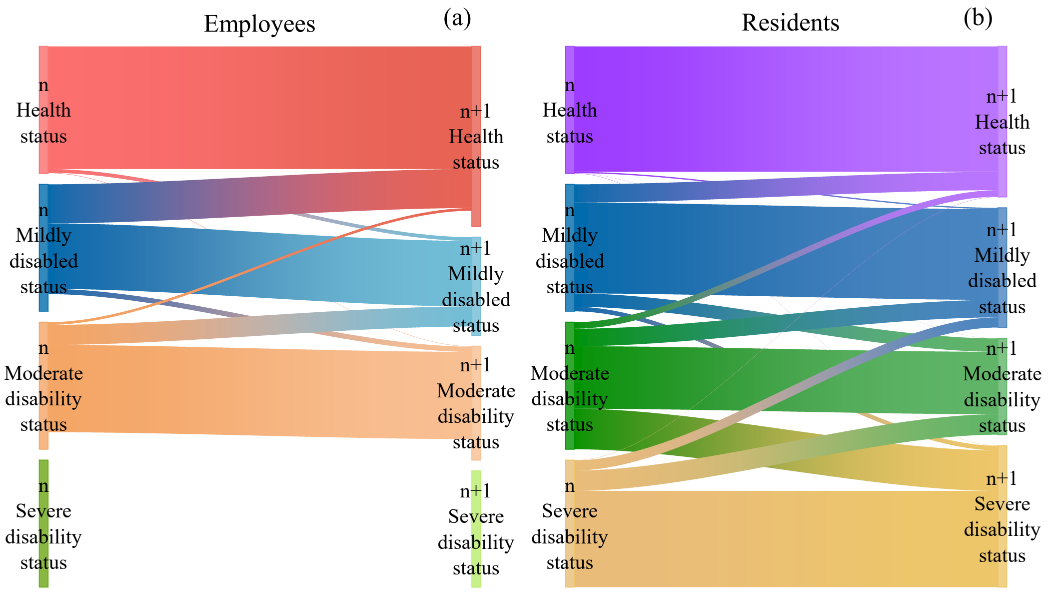

Figure 2 Health status transition for elderly employees and residents

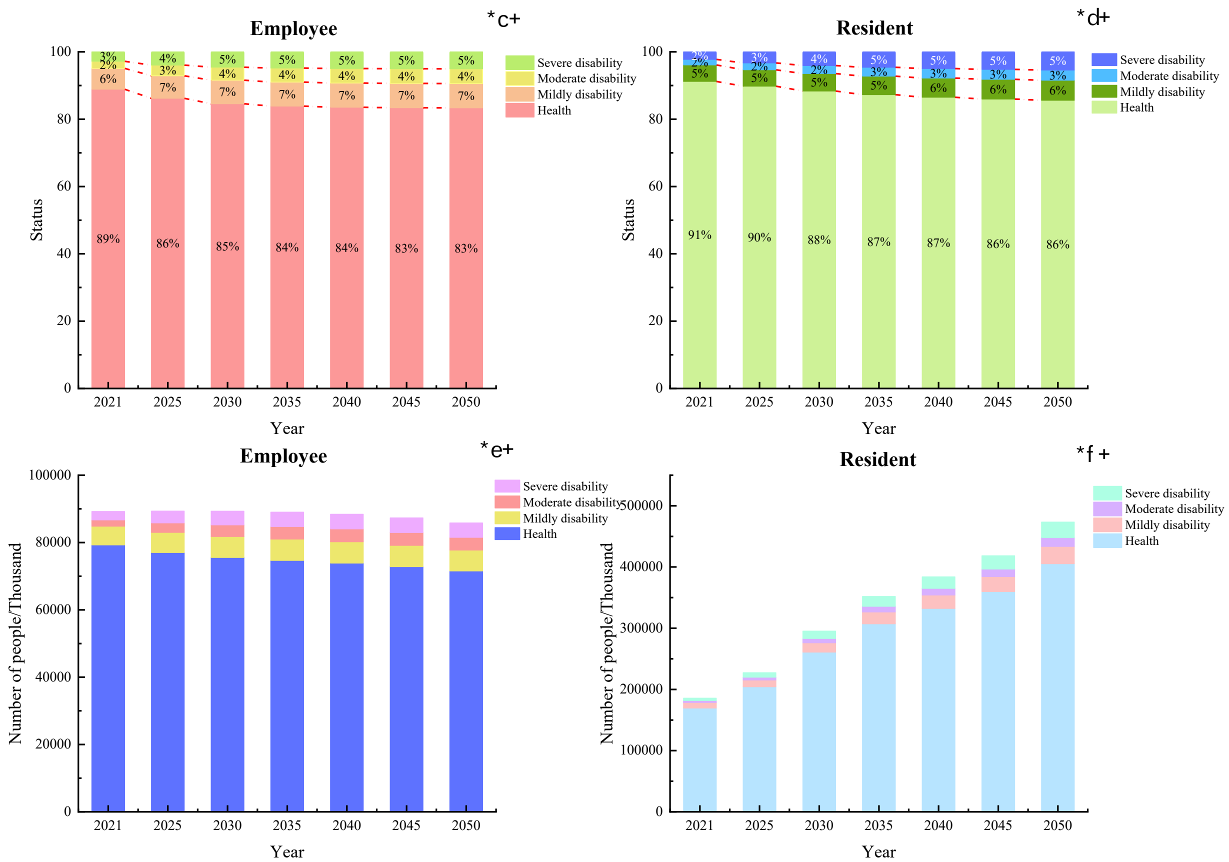

Figure 3 Health status and population forecast of elderly employees and residents

4.3. LTCI Financial Expenditure Forecast Results

Standardize the different nursing methods outlined in Table 2 into annual payment criteria. Utilize Equation (5) presented in Table 6 to calculate the annual expenditure of the LTCI financial for elderly employees and residents across low, medium, and high scenario. Based on the findings in Subsection 3.2, substitute Equation (6) to determine the expenditure of LTCI financial in low, medium, and high scenario from 2021 to 2050, as detailed in Table 7.

Based on the analysis presented in Table 6, the annual expenditure of the LTCI financial is contingent upon the varying levels of disability among the insured population. Specifically, individuals with severe disability are considered the main contributors to the continuous increase in financial expenditures. In accordance with the data presented in Table 7 and Figure 4, variations in beneficiaries and payment standards across the low, medium, and high scenario have a direct impact on financial expenditures. More specifically, the low scenario exclusively caters to severe disability individuals and offers reduced levels of LTC benefits. Projections indicate that by 2050, the LTCI financial for employees is projected to allocate 29.64 billion yuan, while resident expenses are anticipated to escalate to 175.6 billion yuan. Notably, the expenditure scale of the resident financial exceeds that of employees by a factor of 5.92. In addition, the annual demand for resident funds is projected at 408.35 billion yuan, a 2.33-fold increase from the low scenario, with resident financial expenditure surpassing employee expenditure by 5.14 times. The high scenario has extended protection to encompass all individuals with mild, moderate, and severe disability, whilst also elevating the compensation standard, leading to a notable surge in fund demand for both employees and residents. By the year 2050, the projected demand for employee funds is estimated to reach 270.86 billion yuan, which surpasses the low scenario by 9.14 times and the medium scenario by 3.41 times. In parallel, the demand magnitude for resident funds is anticipated at 860.76 billion yuan, exceeding that of the low scenario by 4.90 times and the medium scenario by 2.11 times. Notably, the expenditure scale for resident funds supersedes that of employee funds by a factor of 3.18.

The total expenditure of LTCI funds across various scenarios has exhibited a consistent upward trajectory between 2021 and 2050. The total expenditure within the low scenario escalated from 27.51 billion yuan in 2021 to 205.24 billion yuan in 2050, while the medium scenario saw an increase from 69.67 billion yuan to 487.74 billion yuan. Similarly, the high scenario experienced growth from 215.08 million yuan to 1131.62 billion yuan. Notably, the overall growth rate of financial expenditure for high scenario surpasses that of the medium and low scenarios. Furthermore, the expansion rate of resident financial expenditures exceeds that of employees. Consequently, the trajectory of growth in LTCI financial expenditure will be contingent upon the choice of scenario, necessitating targeted interventions to ensure the financial expenditure scale remains responsive to future challenges.

Table 6 Annual LTCI Expenditure (Unit: Yuan)

Annual expenditure	Low scenario	Medium scenario		High scenario		
	Severe disability	Severe disability	Moderate disability	Severe disability	Moderate disability	Mild disability
Employees	4065.71	6830.98	4662.44	16597.47	11818.07	7143.01
Residents	4065.71	6830.98	4662.44	11161.51	6746.17	4513.87

Table 7 Total expenditure of LTCI financial from 2021 to 2050(Unit: Billion)

Year	Identity	Low scenario	Medium scenario	High scenario

		Severe disability	Severe disability	Moderate disability	Severe disability	Moderate disability	Mild disability
2021	Employees	10.37	17.43	8.89	42.34	22.54	40.27
	Residents	17.14	28.80	14.55	47.06	21.05	41.82
2025	Employees	15.58	26.17	14.45	63.59	36.64	46.60
	Residents	33.19	55.76	23.48	91.11	33.98	54.65
2030	Employees	19.72	33.13	19.14	80.49	48.52	53.10
	Residents	58.26	97.88	39.14	159.93	56.63	82.44
2035	Employees	22.72	38.17	22.44	92.74	56.87	58.92
	Residents	85.38	143.45	56.20	234.40	81.31	113.14
2040	Employees	25.28	42.47	25.13	103.19	63.69	64.38
	Residents	109.81	184.50	71.70	301.46	103.75	139.82
2045	Employees	27.51	46.23	27.46	112.32	69.62	69.66
	Residents	137.32	230.73	89.13	377.00	128.96	170.83
2050	Employees	29.64	49.79	29.60	120.99	75.02	74.85
	Residents	175.60	295.03	113.32	482.07	163.96	214.73

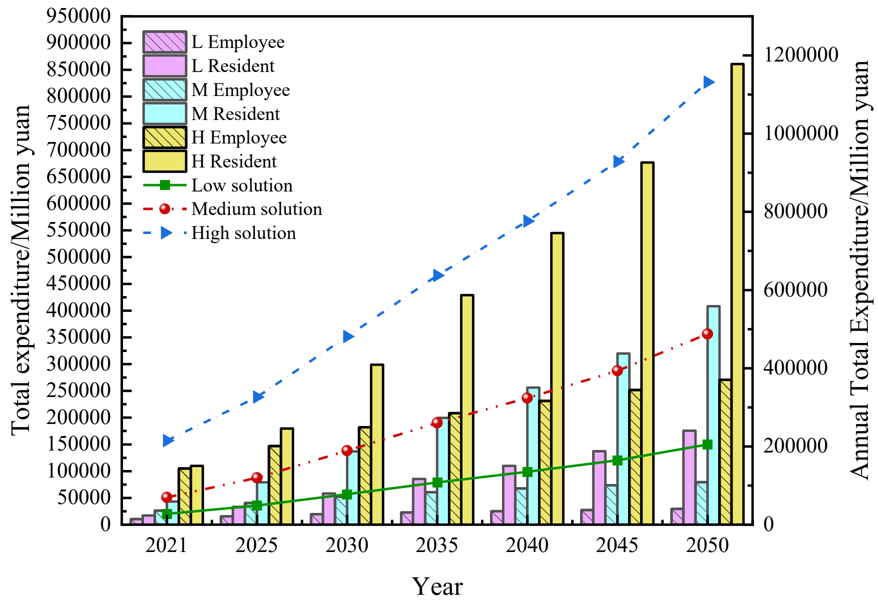

Figure 4 Total financial expenditure under low, medium, and high scenario

5. Discussion

With the continuous growth of elderly population, it is necessary for the government to formulate LTCI policies to effectively address the challenges brought by an aging society. Accurately measuring LTCI financial expenditures is crucial for the government to formulate appropriate policies in this field. The existing research and prediction models have not fully considered the impact of changes in health status and variations in financial reimbursement levels among distinct groups, such as employees and residents. Through empirical analysis, this paper reveals that over the next three decades, the population of elderly residents is projected to surpass that of elderly employees, indicating a consistent upward trend.

In terms of health status, elderly employees demonstrate better health status relative to residents as a result of their favorable living conditions, access to medical services, and healthy dietary habits. In contrast, residents are at greater risk of experiencing deteriorating health conditions. While the reimbursement level for elderly employees surpasses that of elderly residents, the combination of a larger population size and poorer physical health among residents will lead to considerably higher LTCI costs for residents compared to employees. The variations in available options and deviations from previous research findings further accentuate this disparity(Brown et al., 2012). Presently, in accordance with the policies enacted in the initial group of pilot cities, funding for LTCI for employees primarily stems from the reallocation of resources from basic medical insurance pooling accounts and individual accounts. Funding for LTCI for residents is sourced from the redistribution of the pooling accounts designated for basic medical insurance for residents, supplemented by government financial subsidies(Li et al., 2024). The magnitude and rate of growth in LTCI financial spending differ between elderly employees and residents across various scenarios. Based on data released by the National Healthcare Security Administration(*Statistics of the National Medical Security Bureau Statistical Bulletin on the Development of National Medical Security in 2022*, 2023), the employee medical insurance financial generated revenues of 2079.33 billion yuan and incurred expenditures of 1524.38 billion yuan. Over the past five years, the average balance rate stood at 21.66%. Correspondingly, the resident medical insurance financial recorded an income of 1012.89 billion yuan, coupled with expenditures amounting to 935.34 billion yuan, resulting in an average balance rate of 7.4% during the same period. In the year 2023, the demand for LTCI funds among employees across low, medium, and high scenarios represented 0.96%, 2.47%, and 9.31% of the income of the employee medical insurance fund in 2022. Likewise, the expenditure scope of the resident medical insurance fund accounted for 2.49%, 6.05%, and 14.30% of the income obtained by the resident medical insurance fund. It is evident that within the existing financing structure, opting for a high scenario by residents would result in the LTCI financial expenditure surpassing the surplus of the residents' medical insurance fund(R. L. Kane & Kane, 2001). Despite the fact that the expenditure for the employee LTCI fund remains below the surplus of the employee medical insurance fund, falling within acceptable parameters, Nevertheless, over the ensuing thirty years, the swift escalation in the population of elderly employees and residents, alongside the persistent decline in their health conditions, is projected to result in a substantial rise in financial expenditure levels(Kaye et al., 2017). In the absence of modifications to the current funding framework, the LTCI system may encounter challenges in achieving sustainable development, particularly in the context of financing and benefit provision for LTCI for residents, which are anticipated to confront heightened financial obstacles(Feng et al., 2020).

This paper has significant policy implications. Based on the research findings, suggestions have been proposed for formulating LTCI policies. Firstly, it is recommended that the Chinese government prioritize the establishment of a comprehensive health security system encompassing prevention, treatment, rehabilitation, and long-term care. In terms of LTC services, attention should be directed towards disability prevention and rehabilitation training to minimize the occurrence of disabilities. Secondly, the institutional design should take into account residents with a significant demographic, channeling medical and social resources towards residents as extensively as feasible, and emphasizing aesthetics and health to enhance the residents' working and living environment. Furthermore, the long-term care insurance for residents should establish an optimal standard of treatment and reimbursement to guarantee comprehensive coverage without imposing a significant burden on medical insurance funds and government finances(Pot et al., 2022). Lastly, the LTCI fund should be distinct from the basic medical insurance fund, with the creation of independent, diversified, and cost-effective financing mechanisms to ensure the system's sustainable advancement(Rothgang, 2010).

The paper is further constrained by the challenges of acquiring data on cognitive, perceptual, and communication skills through CHARLS to evaluate levels of disability. As a result, only particular indicators were chosen to measure activities of daily living. The absence of indicators pertaining to dementia potentially compromises the accuracy of the measurement outcomes(Collopy, 1988).

With regards to benefit payment, this study will focus on elderly individuals aged 60 and above, excluding middle-aged and young people with disabilities. This approach could impact the accuracy of the predictions regarding LTCI financial expenditures. In assessing the scale of expenditures for the LTCI financial, it is noted that the initial pilot cities primarily provided coverage for severely disabled employees, with limited protection extended to elderly residents and individuals with moderate to mild disabilities in only a few areas(Grabowski, 2007; R. A. Kane, 2001). Due to data constraints, there is a need to enhance the justification for setting benefit payment levels under low, medium, and high scenarios(Dyck et al., 2005). Further research will delve deeper, and with the data becoming available from pilot cities, these data limitations are expected to be addressed and rectified.

6. Conclusion

This paper draws upon data from the 7th National Population Census, the annual communique on development of medical security, and the China Health and Retirement Longitudinal Survey. Utilizing the policy framework of the initial pilot cities for LTCI and predictions concerning populations with varying health conditions, the paper forecasts the expenditure of the LTCI financial for both employees and residents. Furthermore, it analyzed the fluctuations in LTCI financial expenditures from 2021 to 2050 under low, medium, and high scenarios. In the context of an aging population, China's overall population is experiencing a gradual decline. However, the demographic of individuals aged 60 and above, both employees and residents, is steadily increasing at an accelerated rate. The demand for LTC services is escalating, particularly among residents who are more prone to health deterioration compared to employees, thereby driving the surge in LTCI demand. In 2050, the financial expenditure was 205.23 billion yuan under the low scenario, marking a 7.46-fold increase compared to figures in 2021. The financial expenditure under the medium and high scenarios is 2.38 times and 5.51 times greater than that of the low scenario. Notably, from 2021 to 2050, resident financial expenditures surpass those made by employees. Across the low, medium, and high scenarios, the share of employee financial expenditures declines gradually, while resident financial expenditures see continuous growth. Specifically, under the low scenario, the proportion of employee and resident financial expenditures relative to the total financial expenditure rose from 37.7% and 62.2% in 2021 to 14.44% and 85.56% in 2050. It is anticipated that the share of resident LTCI financial expenditure will rise progressively in the future.

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