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Projections of socioeconomic costs of dementia in China 2020-2050: modelling study

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Abstract

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We synthesized health and demographic trends by a Markov model, using data from China Health and Retirement Longitudinal Study and Chinese Longitudinal Healthy Longevity Survey. We decomposed socioeconomic costs changes (2018 US$) into population growth, population ageing, dementia prevalence and average socioeconomic costs per case.

Socioeconomic costs and the value of QALYs lost to dementia will reach $1,233 and $702 billion by 2050, rising by 563% and 457% over 2020-2050. Informal care is currently, and projected to remain, the largest share of socioeconomic costs. Population ageing (43%) and rising dementia prevalence (54%) drive this growth through 2050.

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Projections of socioeconomic costs of dementia in China 2020-2050: modelling study

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Quality Adjusted Life Years (QALYs); Cognitive impairment (CI); Functional impairment (FI); Cardiovascular disease (CVD); China Health and Retirement Longitudinal Study (CHARLS); Chinese Longitudinal Healthy Longevity Survey (CLHLS); Activities of Daily Living (ADL); Instrumental Activities of Daily Living (IADL); Diagnostic and Statistical Manual of Mental Disorders (DSM); International Classification of Diseases (ICD); United Nations (UN); Long-term Care Insurance (LTCI)

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Abstract

INTRODUCTION: This study measured current and projected future socioeconomic costs (healthcare, formal care, and informal care costs) and quality adjusted life years (QALYs) lost to dementia in China, and assesses drivers of these costs.

METHODS: We synthesized health and demographic trends by a Markov model, using data from China Health and Retirement Longitudinal Study and Chinese Longitudinal Healthy Longevity Survey. We decomposed socioeconomic costs changes (2018 US$) into population growth, population ageing, dementia prevalence and average socioeconomic costs per case.

RESULTS: Socioeconomic costs and the value of QALYs lost to dementia will reach $1,233 and $702 billion by 2050, rising by 563% and 457% over 2020-2050. Informal care is currently, and projected to remain, the largest share of socioeconomic costs. Population ageing (43%) and rising dementia prevalence (54%) drive this growth through 2050.

DISCUSSION: Dementia will become an increasingly large economic burden on Chinese society.

Keywords: Dementia; Socioeconomic Costs; Costs of Quality of Life Lost; Modelling Studies; China

1 INTRODUCTION

Dementia represents a significant societal burden. While most studies on the costs of dementia are carried out in high-income countries such as Japan [1], the United States [2, 3] and European countries [4], evidence for low- and middle-income countries is scarce. We focus on China, where population ageing, resulting from growing life expectancy and declining fertility, is expected to rapidly increase the number of dementia cases and its associated costs [5].

There is only a handful of studies that estimated future socioeconomic costs of dementia in China, varying from $368 to 2,617 billion in 2050 [5-7]. Although dementia care in China is primarily taken place at home and in the community [8], prior studies instead mainly recruited patients from hospitals or nursing institutions [5, 7], leaving out those untreated patients hiding in the community. There is yet any community-based study on a national scale. Furthermore, previous evidence focuses on three types of socioeconomic costs, namely healthcare, formal care, and informal care, while the Quality Adjusted Life Years (QALYs) lost due to dementia have not been considered [9]. As a summary measure of disease burden, QALYs encompassed both the quantity and quality of life. This is particularly relevant for intangible cost estimation of dementia, as patients' quality of life deteriorates significantly as the neurodegenerative disease progresses over approximately 8–10 years [10].

Less is known about the main drivers of dementia socioeconomic costs in China. As far as we know, the only relevant study is by Xu, who indicated the main contributors were population ageing and dementia prevalence [8]. However, Xu projected future

dementia prevalence mainly based on previous estimates, failing to account for variations in the temporal trend of dementia incidence, which may fundamentally influence the projected number of dementia cases and the corresponding costs [5]. Given the projected declines in the Chinese population and anticipated increases in costs per case, the extent to which these changes will contribute to future dementia-related costs requires further investigation [11].

Our study projected the socioeconomic costs and value of QALYs lost to dementia in China between 2020 and 2050. Additionally, we evaluated four factors that drive the socioeconomic costs, namely, population growth, population ageing, dementia prevalence, and average socioeconomic costs per dementia case.

2 METHODS

2.1 Study design and sample

To forecast socioeconomic costs and QALYs lost to dementia between 2020 and 2050, we conducted a simulation modelling approach utilizing the IMPACT Chinese Ageing Model (IMPACT-CAM). This multistate-Markov microsimulation model has been previously developed and validated [12]. IMPACT-CAM projected age- and sex-specific dementia cases of these aged 50+ years by year to 2050. Corresponding costs and the value of QALYs lost associated with these dementia cases were estimated in this study.

Prevalence of dementia and other related states (e.g. cognitive impairment (CI), functional impairment (FI), cardiovascular disease (CVD), and death) and transition probabilities between health states were estimated using two nationally representative

datasets, namely, the China Health and Retirement Longitudinal Study (CHARLS) [13] and the Chinese Longitudinal Healthy Longevity Survey (CLHLS) [14]. These two cohorts are widely used in China healthy ageing studies [15, 16]. We included 24,983 CHARLS participants living in the community, who provide high-quality data on healthcare costs, informal care usage and QALY. Another 33,249 CLHLS participants were included to provide additional data on formal care usage, covering both community and nursing home settings. The sample selection flowchart was shown in Figure S1.

2.2 Case definition of dementia

We defined an individual to have dementia if s/he has a combination of CI and FI or if s/he self-reported his/herself to have doctor-diagnosed dementia or memory-related disease. CI was defined as an impairment in two or more domains of cognitive function, measured using the modified Telephone Interview for Cognitive Status questionnaire via a face-to-face interview in CHARLS [13] and Mini-Mental State Examination in CLHLS [14]. Based on confirmatory factor analysis [17], a common three-factor cognitive construct of orientation, memory, and executive function and language was found for both datasets. Domain-specific impairment was quantified if an individual scored 1.5 standard deviations below the mean factor score of the counterpart population with the same level of education. Those who require assistance in performing one or more Activities of Daily Living (ADL) were defined as functionally impaired. Participants' ADLs were measured by Katz ADL scale [18]. This definition of dementia was adapted to resemble Diagnostic and Statistical Manual of Mental

Disorders (DSM)-IV, DSM-5, and International Classification of Diseases 10th edition for diagnosis of dementia.

2.3 Definition of socioeconomic costs and utility weights for QALYs

2.3.1 Healthcare costs

In CHARLS, respondents were asked to report healthcare costs of outpatient care of past month, inpatient care of past year, and self-treatment of past month (i.e. any self-purchased medicine, health supplement and healthcare equipment), including both out-of-pocket payments and insurance reimbursements. We calculated the annual total healthcare costs by summarizing these three types of costs.

2.3.2 Formal care costs

Formal care costs were the product of formal care usage and its unit price. Formal care usage was derived from CLHLS participants, who had FI and received care from formal caregivers (i.e. housekeepers and social services providers), plus those without FI but currently living in a nursing home. The age-, sex- and health states-specific formal care usage of CLHLS were then used to estimate the corresponding probabitliy for their CHARLS counterparts.

Considering different prices between formal care at home and in nursing homes, an average unit price of formal care was estimated by calculating the weighted average unit prices of these two settings (Eq.1). The unit price of formal care at home was estimated at $9,259, corresponding to the annual average wage of services providers, as reported by the lastest National Bureau Statistics [19]. The unit price of formal care in nursing homes was assumed to be twice as expensive as formal care at home, to

reflect extra costs of accommodations and meals, etc. based on the observed in CLHLS.

$$Y = A \times a\% + B \times b\% \quad (1)$$

$$Y = Unit\ price\ of\ formal\ care.$$

$$A = Unit\ price\ of\ formal\ care\ at\ home.$$

$$a\% = Population\ share\ of\ those\ living\ at\ home.$$

$$B = Unit\ price\ of\ formal\ care\ in\ nursing\ home.$$

$$b\% = Population\ share\ of\ those\ living\ at\ home.$$

2.3.3 Informal care costs

Informal care costs were the product of informal care hours and the hourly unit price. Informal care hours were calculated by CHARLS participants with ADLs, or Instrumental Activities of Daily Living (IADLs) limitations, who reported the number of hours given per month by family or friends. Unit price of informal care was estimated at $4.5 per hour via the opportunity costs approach, assuming the total value of 2,080 hours informal caregiving per year (40 hours/week, 52 weeks/year) [20] equivalent to the annual average wage of service personnel (i.e. $9,259) [19].

2.3.4 Utility weights for QALYs

Utility weights for QALYs were obtained based on EQ-5D instrument and the utility values. EQ-5D instrument is a health-related quality of life questionnaire widely used in economic, clinical, and population health studies [21]. In CHARLS, participants answered five health profile questions, which were analogous to the five domains of the EQ-5D instrument (anxiety/depression, pain/discomfort, usual activities, self-care, and mobility) [22] (Table S1). Furthermore, based on their answers to these questions, we obtained their utility weights for QALYs, using Chinese utility values for EQ-5D health states elicited from a general population [23],

2.4 Statistical analysis

2.4.1 Projection of socioeconomic costs and value of QALYs lost to dementia

Age- and sex-specifc socioeconomic costs of dementia were estimated by a mixed model with age, sex, health status (dementia, CVD, FI, and their combination, altogether eight health states) and year (2011-2018). Future socioeconomic costs matching dementia cases of IMPACT-CAM were projected based on the estimated coefficients from the mixed model, assuming that age- and sex-specific costs of dementia would experience linear changes on an annual basis. Similar mixed model with observed utility weights as outcome was used to estimate age- and health states-specific utility weights. QALYs lost to dementia were then calculated as the differences of the annualized utility weights between the general population [24] and dementia patients multiplied by the number of dementia cases predicted by IMPACT-CAM. The QALYs lost were valued at $36258, which is three times the country-level gross domestic product per capita [25] in line with previous studies.

Following previous research [26], we assumed 95% uncertainty intervals represented +/- 20% of these cost point estimates, which were applied in addition to the epidemiological uncertainty surrounding the proportion of the population in each health state. Given the low level of uncertainty surrounding utility weights for QALYs, any variation in the results for QALYs was only attributable to epidemiological uncertainty. Sensitivity analyses were further conducted to account for uncertainty in the future trend of dementia incidence. We assumed that dementia incidence grew at an annual rate of 2.9% in our main analysis of IMPACT-CAM [27]. Given nationwide prevention

may potentially alter dementia incidence, we set the temporal trend of dementia incidence to be flat or decrease by 1.0% per annual [5] for sensitivity analyses. All observed costs were deflated to 2018 US$, with an exchange rate of $1.0 equivalent to 6.7 Chinese yuan (details in supplementary costs estimation methods).

2.4.2 Main drivers of socioeconomic costs of dementia

The Das Gupta decomposition method [28] is a common approach used to decompose the growth of health expenditure into the effects of different factors [11, 29]. The idea is to perform counterfactual scenarios and compare the outcomes in these different scenarios. This approach distributes interaction effects among the four factors across the main effects, which does not change conclusions about the relative importance of the drivers, but only simplifies the picture [30]. Based on this method, we decomposed the socioeconomic costs of dementia into four drivers, namely, population growth, population ageing, dementia prevalence, and average socioeconomic costs per dementia case. The aggregate socioeconomic costs of dementia can be expressed as the product of these drivers (Eq.2).

$$cost_{a,s,h,y} = Pop_y \times \frac{pop_{a,s,y}}{Pop_y} \times \frac{cases_{a,s,h,y}}{pop_{a,s,y}} \times \frac{Cost_{a,s,h,y}}{Cases_{a,s,h,y}} \quad (2)$$

where total costs of all individuals of age *a*, sex *s*, with health state *h* in year *y,* is a function of population in year *y*, the share of the population in that year who is age *a* and sex *s*, the share of the population who is age a and sex s with health state *h*, and the average costs of people with that health state. The calculations and age ranges are shown in Table 1.

Based on the Eq.2, we calculated the share of the growth in total dementia costs

from 2020 (reference group) to 2050 attributable to each factor, which was defined as the relative contribution of that factor. The sum of the relative contribution of all factors in each year was equal to 100%.

3 RESULTS

3.1 Projection of socioeconomic costs and value of QALYs lost

The basic characteristics of CHARLS and CLHLS are shown in Table S2-S3. Figure 1 shows the age group-specific aggregate costs and average costs per dementia case in 2020. It shows that informal care accounted for the largest share of aggregate socioeconomic costs (71%), whereas formal care was responsible for the smallest share (3%). The aggregate costs of dementia were the lowest for 90-100 years old age group. Although dementia prevalence rose with age, the total number of people alive declined with age due to mortality. In contrast, the costs were the highest for the 70-79 years old age group, due to high dementia cases for this group.

The temporal trends of average costs per case and the aggregate costs from 2020 to 2050 are shown in Figure 2. The average socioeconomic costs and value of QALYs lost to dementia were $15,391 and $10,433 per case in 2020, respectively, and will continue to grow to $18,570 and $10,586 in 2050. The annual aggregate socioeconomic costs and value of QALYs lost to dementia are projected to grow from $186, and $126 in 2020 to $1,233 billion, and $702 in 2050. The costs of informal care are projected to grow at the fastest rate. The uncertainty intervals of these projections are showed in Table S4.

Figure 3 shows that the socioeconomic costs of dementia depend heavily on the

assumed temporal trend of dementia incidence. The main analysis set the annual growth rate of dementia incidence to be 2.9%. If dementia incidence stays constant or decreases by 1.0% annually, the socioeconomic costs would respectively decrease by 34% or 43% in 2050 relative to our main analysis.

3.2 Main drivers of socioeconomic cost

During the period from 2020 to 2050, the population in China will decrease from 1433 million to 1320 million, and the age structure will change significantly. The population size in the age groups 60-70, 70-80, 80-90, and 90+ will increase from 148, 76, 29, and 4 to 210, 167, 116, and 21 million respectively, while the share of the age group 50-59 sharply will decrease from 218 million to 175 million. Concurrently, dementia prevalence increased from 3% to 11% during the same period.

Our main analysis shows that the largest driver of the rising socioeconomic costs of dementia between 2020 and 2050 is growing dementia prevalence (54%), followed by population ageing (43%) (Figure 4). Although dementia prevalence is the dominant driver over time, the relative contribution of it decreases over time, accompanied by an increasing trend of that of population ageing. Using 2020 as the base year, the relative contribution of per capita healthcare costs is relatively stable between 2020 and 2050. Total population growth is negatively associated with socioeconomic costs' growth, reflecting declines in the projected Chinese population size.

Figure S2 shows the relative contribution of each factor for different trends of dementia incidence. If dementia incidence decreases by 1.0% annually or stays constant in the future, population ageing would gradually replace dementia prevalence as the

dominant driver. Specifically, if dementia incidence is to decrease by 1.0% annually, the relative contribution of dementia prevalence and population ageing and dementia prevalence would be 41% and 51% between 2020 and 2021, respectively. By 2050, these two numbers will shift to 63% and 32%, respectively. A similar pattern of relative contribution is found for the case where dementia incidence stays constant.

4 DISCUSSION

Our prediction shows that China's socioeconomic costs and value of QALYs lost to dementia will rise from $186 billion and $145 billion in 2020 to $1233 billion and $823 billion by 2050, respectively. The largest component of the estimated socioeconomic costs is informal care. Growth in these costs is mainly driven by rapid population ageing and growing prevalence of dementia in the coming decades.

Our study provides a robust projection of China's future costs of dementia using a microsimulation modelling approach and estimations of several cost measures based on nationwide population samples. The projected aggregate socioeconomic costs of dementia are within the range of previous studies, and the estimated magnitude of the increase over the next three decades in our study is close to previous forecasts [5-7] (Table S5, Figure S3). Specifically, our estimate of current and future costs is higher than Huang's study, which utilized data from provincial surveys and prior small-area studies [6], but lower than Jia's study which used dementia patients recruited overwhelmingly from urban hospitals [5, 7]. In addition to differences in study samples' representativeness, our study advances the evidence by taking into account the time effect in cost estimation, which is vital to indicate potential technological innovation

[31] and increased labor costs [32]. Moreover, we filled the gap in current dementia costs literature about China by providing firsthand evidence on the previously neglected value of QALYs lost to dementia. The estimated value of QALYs lost due to dementia of Chinese older adults was 2.6 times healthcare costs in 2020, equivalent to findings revealed by a UK-based study [26]. This substantial societal cost contributes to a more complete picture of economic implications of dementia, and allows for comparisons with other health conditions, to guide healthcare policies and resource allocation decisions.

This study shows that informal care costs are currently the largest share of China's socioeconomic costs of dementia, and are projected to remain. Corresponding to Jia's study [7], which found that about half of socioeconomic costs were informal care costs, our findings further underscore the pivotal role of informal care costs, estimated to account for over two-thirds of the total socioeconomic costs. This could be due to our representative sample, which consists of a significant number of individuals with dementia residing in community-based settings, where the burden on informal caregivers tends to be more substantial [33]. Heavy use of informal care is commonly seen in developing countries [34], where the formal care system is less well-developed. Despite China's long-term care insurance (LTCI) has been piloted since 2016, the relevant welfare benefits have not been given full consideration to individuals with cognitive impairments [35]. Lacking access to formal care combined with preferences for family care [36] results in informal care making up the largest proportion of care and accounting for the majority of dementia costs. However, current support for

informal caregivers is patchy and regulation of informal care is inadequate [37], calling for tailored policies that support informal caregivers and ensure the quality of care for people with dementia.

Among the four factors affecting future dementia costs, we identified population ageing and dementia prevalence are the two main drivers, while less than 10% were attributed to growth in the population and the average socioeconomic costs per dementia case. Compared with Xu's study [38] where only dementia prevalence and population ageing were considered as drivers of dementia cost, we extended it by including population growth and average costs per case. The ageing of the Chinese population is estimated to significantly contribute to increased dementia costs. This is consistent with Zhai's finding that the impact of population ageing on increasing healthcare costs after 2012 was greater than between 1993-2012 [11, 39]. Moreover, we found over half of the socioeconomic costs' growth is attributable to increasing dementia prevalence, and our sensitivity analyses indicated that there is large scope for reducing these costs by decreasing dementia incidence. As much as 44% of all dementia cases can be prevented or delayed by changing modifiable risk factors [40]. Early detection and intervention are critical for reducing dementia incidence, and consequently alleviating its associated socioeconomic costs.

Our study has the strength that we used two nationally representative datasets of the Chinese population that capture all types of socioeconomic costs of health care, formal and informal care, and value of QALYs of dementia in China. However, there are several limitations in this study. First, we utilized the best available evidence, but

the estimated cost could inevitably be influenced by a recall bias in self-reported healthcare costs or the huge variation in the unit price of formal care in China. Further studies would benefit from linkage data to hospital electronic records or LTCI insurance information to enhance reliability. Second, based on the consecutive waves of observation, we assumed that the estimated socioeconomic cost will increase linearly by year. However, this assumption may be violated due to various factors, such as the impact of the LTCI policies on formal care usage or the implementation of policies aiming to support informal caregivers. Third, to fully consider the important comorbidities of dementia, such as CVD, IMPACT-CAM does not consider the severity of different physical impairments. Given the influence of the severity of dementia on costs [41], future studies should further explore differences in the socioeconomic costs of dementia using finer gradations of both dementia and the factors impacting dementia.

5 CONCLUSIONS

The socioeconomic costs and the value of QALYs lost to dementia in China are projected to increase rapidly in the future, with informal care continuing to account for the largest proportion of the socioeconomic costs. Policy support for informal caregivers needs to be improved and interventions targeting risk factors should be introduced to reduce the socioeconomic costs of dementia. Given that population ageing and dementia prevalence are the main drivers of future socioeconomic costs of dementia in China, policies that reduce the prevalence of dementia and support healthy ageing should be implemented to mitigate the projected growth of socioeconomic costs of dementia.

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CONFLICTS OF INTEREST AND DISCLOSURE STATEMENT

The authors have no relevant conflicts of interest to disclose.

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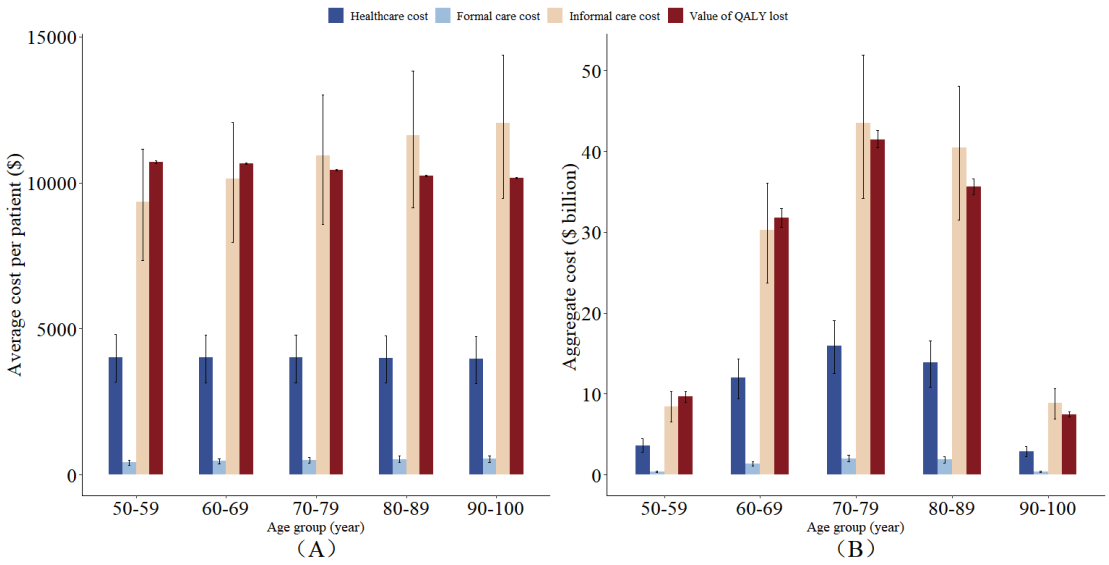

Figure 1 Age group-specific average costs per case (A) and aggregate costs (B) in 2020

Note. Survey data sources were CLHLS and CHARLS, and the projections came from IMPACT Chinese Ageing Model. Average annual costs per case mean the average annual dementia costs per case with dementia. Aggregate costs are equal to average costs per case multiplied by the number of dementia cases. Given the low level of uncertainty surrounding utility weights for QALYs, any variations in the results for QALYs are solely attributable to epidemiological uncertainty. The number of dementia cases in each age group was 0.9, 3.0, 4.0, 3.5, 0.7 million; OOP: out-of-pocket payments.

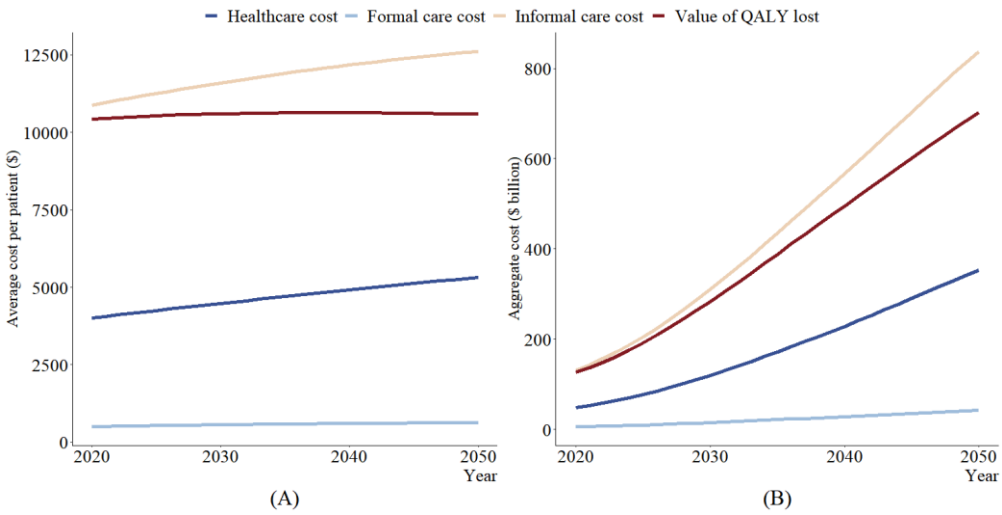

Figure 2 Time trend of average costs per case (A) and aggregate costs (B)

Note. Survey data sources were CLHLS and CHARLS, and the projections came from IMPACT Chinese Ageing Model. Average annual costs per case mean the average annual dementia costs per case with dementia. Aggregate costs are equal to average costs per case multiplied by the number of dementia cases. The number of dementia cases in 2020, 2030, 2040, and 2050 was 12.1, 26.8, 46.6, and 66.3million.

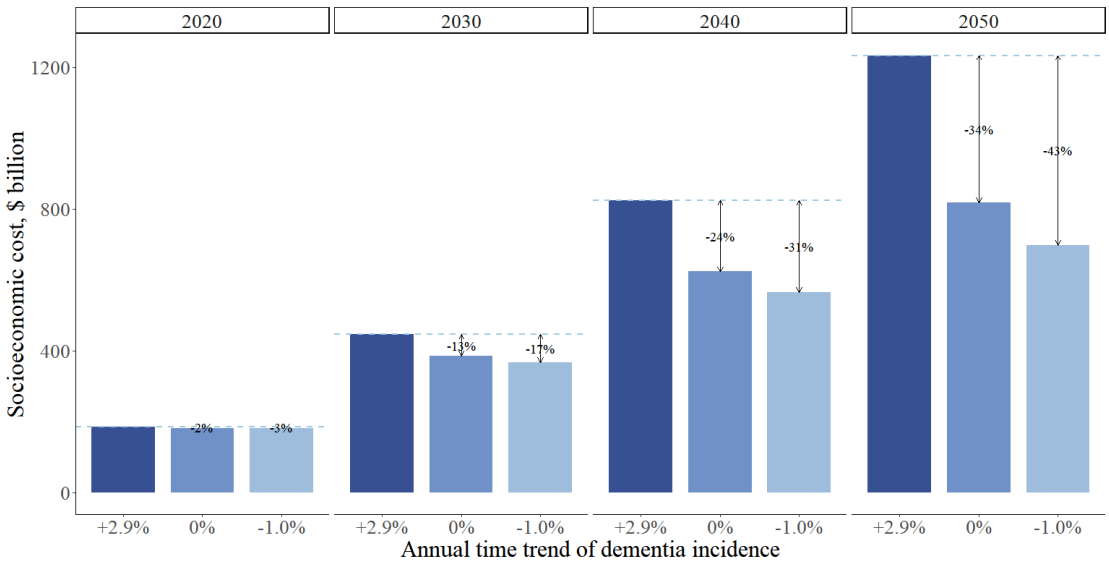

Figure 3 Socioeconomic costs depending on different assumptions of temporal trend of dementia incidence

Note. Survey data sources were China Health and Retirement Longitudinal Study and Chinese Longitudinal Healthy Longevity Survey, and the projections came from IMPACT Chinese Ageing Model. Lines indicated costs difference, and the bar indicated change rate.

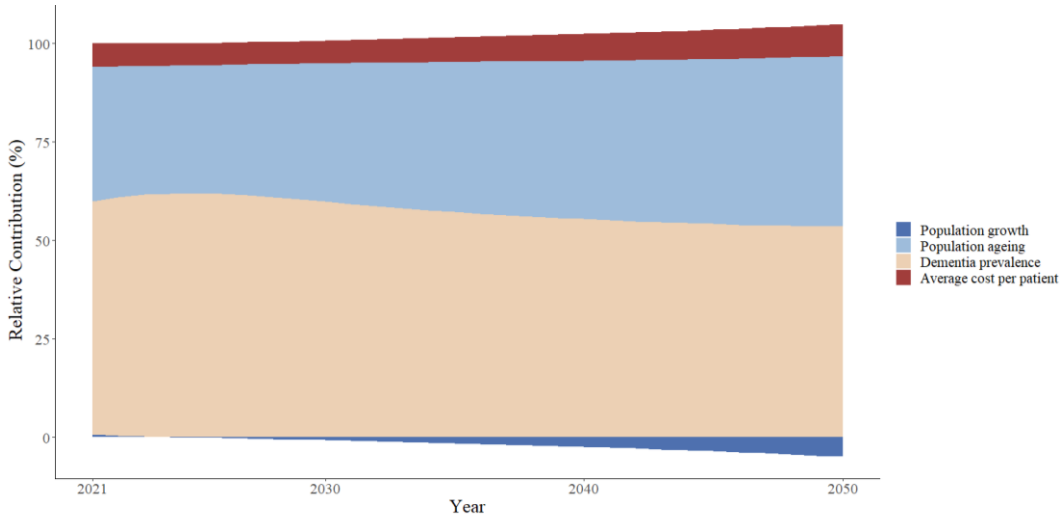

Figure 4 Relative contribution of each factor to socioeconomic costs' growth based on the annual temporal trend of dementia incidence as 2.9%

Note. Values for population growth were derived from the total population size from 2020 to 2050, and came from the United Nations (aged 0+). Population ageing was equal to population size in each age, sex group divided by total population size (aged 50+). Dementia prevalence was equal to the number of dementia cases divided by population size in each age, sex group (aged 50+). Average costs per case were equal to aggregate socioeconomic costs divided by the number of dementia cases (costs included healthcare costs, formal care costs and informal care costs for those aged 50+).

Table 1 Calculation of four drivers

Drivers	Calculation	Age range
Population growth	$Total\ population\ size$	0+
Population ageing	$\frac{Population\ size\ in\ each\ age,gender\ group}{Total\ population\ size}$	50+
Dementia prevalence	$\frac{Number\ of\ dementia\ cases}{Population\ size\ in\ each\ age,gender\ group}$	50+
Average socioeconomic costs of dementia	$\frac{Aggregate\ socioeconomic\ cost\ of\ dementia}{Number\ of\ dementia\ cases}$	50+

Note. United Nations forecasts of population growth and ageing were used as demographic factors in our model. Non-demographic factors included growth in dementia prevalence (conditional on age and sex) projected by IMPACT Chinese Ageing Model and average socioeconomic costs per case, which we estimated using the China Health and Retirement Longitudinal Study, and Chinese Longitudinal Healthy Longevity Survey.

SUPPLEMENTAL MATERIALS

Projections of the socioeconomic cost of dementia in China 2020-2050: modelling study

Table S1 Item construct of EQ-5D in CHARLS

Original EQ-5D items and three levels		Questions in CHARLS	Options in CHARLS	Recode three levels
Mobility	I have no problems in walking I have some problems in walking I am confined to bed	**Do you have difficulty …** Running or jogging about 1 Km Getting up from a chair after sitting for a long period Stooping, kneeling, or crouching Reaching or extending your arms above shoulder level Lifting or carrying weights over 10 jin	(1) No, I don't have any difficulty (2) I have difficulty but can still do it. (3) Yes, I have difficulty and need help. (4) I cannot do it.	**level 1 no problems, level 3 unable to do** level 1 = (1) level 2 = (2)/(3) level 3 = (4)
Self-care	I have no problems with self-care I have some problems washing or dressing myself I am unable to wash or dress myself	**Do you have difficulty …** Dressing Bathing or showering Eating Getting into or out of bed Using the toilet, including getting up and down	(1) No, I don't have any difficulty (2) I have difficulty but can still do it. (3) Yes, I have difficulty and need help. (4) I cannot do it.	level 1 = (1) level 2 = (2)/(3) level 3 = (4)
Usual activities	(e.g. work, study, housework, family or leisure activities) I have no problems with performing….. I have some problems with performing …..	**Do you have difficulty …** Doing household chores Preparing hot meals Shopping for groceries Managing your money	(1) No, I don't have any difficulty (2) I have difficulty but can still do it. (3) Yes, I have difficulty and need help. (4) I cannot do it.	level 1 = (1) level 2 = (2)/(3) level 3 = (4)

Original EQ-5D items and three levels		Questions in CHARLS	Options in CHARLS	Recode three levels
	I am unable to perform …..			
Pain/discomfort	I have no pain or discomfort I have moderate pain or discomfort I have extreme pain or discomfort	Are you often troubled with any body pains?	(1) None; (2) A little; (3) Some; (4) Quite a bit; (5) A lot;	level 1 = (1)/(2) level 2 = (3); level 3 = (4)/(5)
		Are you often troubled with any body pains?	(1) Yes; (2) No	level 1 = (1); level 3 = (2)
		Yesterday, did you feel any pain?	(1) None; (2) A little; (3) Some; (4) Quite a bit; (5) A lot	level 1 = (1)/(2); level 2 = (3); level 3 = (4)/(5)
		Are you often troubled with any body pains?	(1) Yes; (2) No	level 1 = (2) no level 2 = (1) yes + (1) mild/ (2)moderate level 3 = (1)yes + (3) severe
		How bad is your pain?	(1) Mild; (2) Moderate; (3) Severe	
Anxiety/depression	I am not anxious or depressed I am moderately anxious or depressed I am extremely anxious or depressed	**Choose the appropriate response refer to how you have felt during the last week.** I was bothered by things that don't usually bother me. I had trouble keeping my mind on what I was doing. I felt depressed. I felt fearful. I felt lonely.	(1) Rarely or none of the time (<1 day) (2) Some or a little of the time (1-2 days) (3) Occasionally or a moderate amount of the time (4) Most or all of the time (5-7 days)	level 1 = (1) level 2 = (2)/(3) level 3 = (4)

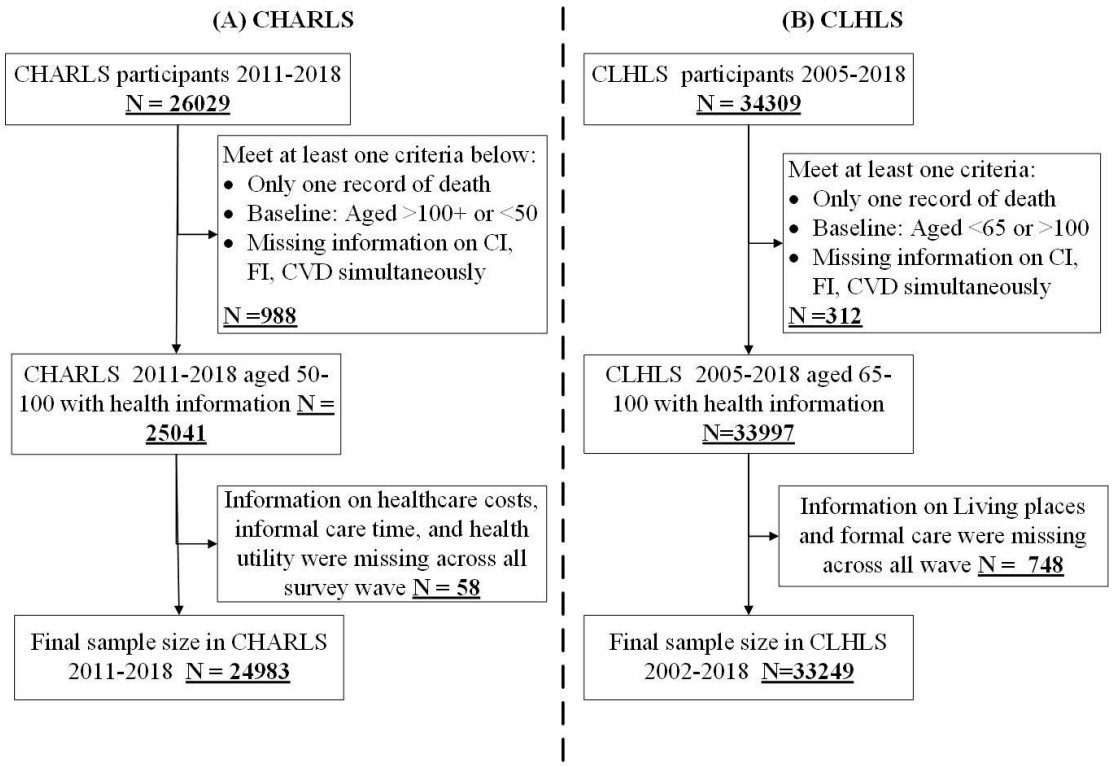

Figure S1 Sample selection flowchart for CHARLS and CLHLS

Note. CHARLS, China Health and Retirement Longitudinal; CLHLS, Chinese Longitudinal Healthy Longevity Survey; CI Cognitive impairment; FI Functional impairment; CVD Cardiovascular Disease.

Table S2 Basic characteristics of CHARLS in each wave

	Wave 2011		Wave 2013		Wave 2015		Wave 2018	
	Without dementia (N=13502)	**Dementia (N=169)**	**Without dementia (N=14945)**	**Dementia (N=200)**	**Without dementia (N=16412)**	**Dementia (N=252)**	**Without dementia (N=17089)**	**Dementia (N=378)**
Age (years)								
Mean (SD)	62.6 (8.53)	74.1 (10.1)	62.9 (8.89)	73.1 (10.0)	63.0 (9.02)	73.3 (9.50)	63.8 (9.27)	72.9 (10.0)
Gender n (%)								
Female	6810 (50.4)	82 (48.5)	7592 (50.8)	90 (45.0)	8390 (51.1)	118 (46.8)	8844 (51.8)	203 (53.7)
Male	6692 (49.6)	87 (51.5)	7353 (49.2)	110 (55.0)	8022 (48.9)	134 (53.2)	8245 (48.2)	175 (46.3)
Total healthcare cost ($)								
Mean (SD)	651 (3670)	2650 (6910)	1130 (14200)	3610 (9290)	1230 (5940)	4060 (13500)	1190 (5920)	4140 (26400)
Missing n (%)	87 (0.6)	3 (1.8)	69 (0.5)	1 (0.5)	57 (0.3)	2 (0.8)	24 (0.1)	0 (0)
Informal social caregiving time (h/month)								
Mean (SD)	16.7 (78.9)	209 (243)	29.4 (96.8)	212 (223)	29.3 (142)	262 (329)	28.5 (126)	276 (379)
Missing n (%)	24 (0.2)	3 (1.8)	343 (2.3)	12 (6.0)	18 (0.1)	2 (0.8)	0 (0)	0 (0)
Informal care cost ($ /year)								
Mean (SD)	842 (3970)	10500 (12200)	1480 (4860)	10700 (11200)	1470 (7150)	13200 (16500)	1440 (6320)	13900 (19100)
Missing n (%)	24 (0.2)	3 (1.8)	343 (2.3)	12 (6.0)	18 (0.1)	2 (0.8)	0 (0)	0 (0)
Utility								
Mean (SD)	0.787 (0.169)	0.386 (0.202)	0.816 (0.158)	0.450 (0.223)	0.772 (0.198)	0.368 (0.231)	0.782 (0.181)	0.424 (0.200)
Missing n (%)	51 (0.4)	27 (16.0)	101 (0.7)	64 (32.0)	101 (0.6)	58 (23.0)	169 (1.0)	84 (22.2)

Table S3 Basic characteristics of CLHLS in each wave

	Wave 2005		Wave 2008		Wave 2011		Wave 2014		Wave 2018	
	Without dementia (N=13170)	**Dementia (N=592)**	**Without dementia (N=13597)**	**Dementia (N=441)**	**Without dementia (N=8380)**	**Dementia (N=340)**	**Without dementia (N=6233)**	**Dementia (N=276)**	**Without dementia (N=12946)**	**Dementia (N=580)**
Age (years)										
Mean (SD)	84.1 (10.8)	93.8 (7.13)	85.0 (10.3)	93.3 (6.74)	84.0 (10.1)	92.8 (7.78)	84.2 (9.51)	91.4 (8.86)	82.9 (10.2)	92.9 (7.21)
Gender n (%)										
Female	7140 (54.2)	394 (66.6)	7360 (54.1)	274 (62.1)	4385 (52.3)	208 (61.2)	3248 (52.1)	167 (60.5)	6909 (53.4)	363 (62.6)
Male	6030 (45.8)	198 (33.4)	6237 (45.9)	167 (37.9)	3995 (47.7)	132 (38.8)	2985 (47.9)	109 (39.5)	6037 (46.6)	217 (37.4)
Receipt of formal care n (%)										
No	12686 (96.3)	497 (84.0)	13264 (97.6)	398 (90.2)	8148 (97.2)	317 (93.2)	6054 (97.1)	245 (88.8)	12416 (95.9)	502 (86.6)
Yes	484 (3.7)	95 (16.0)	333 (2.4)	43 (9.8)	232 (2.8)	23 (6.8)	179 (2.9)	31 (11.2)	530 (4.1)	78 (13.4)
Living in a nursing home n (%)										
No	12850 (97.6)	544 (91.9)	13362 (98.3)	415 (94.1)	8218 (98.1)	327 (96.2)	6075 (97.5)	247 (89.5)	12499 (96.5)	508 (87.6)
Yes	320 (2.4)	48 (8.1)	219 (1.6)	19 (4.3)	159 (1.9)	12 (3.5)	155 (2.5)	26 (9.4)	426 (3.3)	68 (11.7)
Missing	0 (0)	0 (0)	16 (0.1)	7 (1.6)	3 (0.0)	1 (0.3)	3 (0.0)	3 (1.1)	21 (0.2)	4 (0.7)
Formal care cost ($/year)										
Mean (SD)	465 (2380)	2030 (4650)	310 (1960)	1230 (3760)	351 (2080)	857 (3180)	364 (2120)	1420 (4010)	518 (2510)	1700 (4320)

Table S4 Time trend of average cost per patient and aggregate cost of dementia

Year	Healthcare cost	Formal care cost	Informal care cost	Cost of QALY lost
		Average cost per patient ($)		
2020	4011.3 (3147.5, 4770.6)	502.6 (395.4, 599.0)	10878.2 (8543.3, 12947.3)	10433.3 (10421.5, 10445.2)
2030	4476.9 (3513.4, 5325.2)	565.9 (446.1, 674.4)	11586.9 (9098.9, 13800.0)	10593.9 (10574.1, 10613.2)
2040	4909.6 (3852.2, 5839.8)	608.0 (479.0, 725.4)	12170.4 (9558.0, 14488.6)	10630.6 (10612.2, 10649.2)
2050	5324.8 (4177.2, 6333.4)	633.6 (498.7, 755.6)	12608.1 (9903.9, 15020.8)	10586.0 (10568.1, 10604.3)
		Aggregate cost (billion $)		
2020	48.4 (38.0, 57.8)	6.1 (4.8, 7.2)	131.4 (103.0, 156.8)	126.0 (123.9, 128.1)
2030	119.9 (94.2, 142.9)	15.2 (12.0, 18.1)	310.5 (244.1, 370.0)	283.6 (276.8, 290.3)
2040	228.7 (178.8, 271.9)	28.3 (22.2, 33.8)	566.9 (443.1, 674.9)	495.0 (483.6, 507.5)
2050	353.4 (276.2, 421.1)	42.1 (32.9, 50.2)	837.6 (653.8, 997.3)	702.1 (685.3, 719.8)

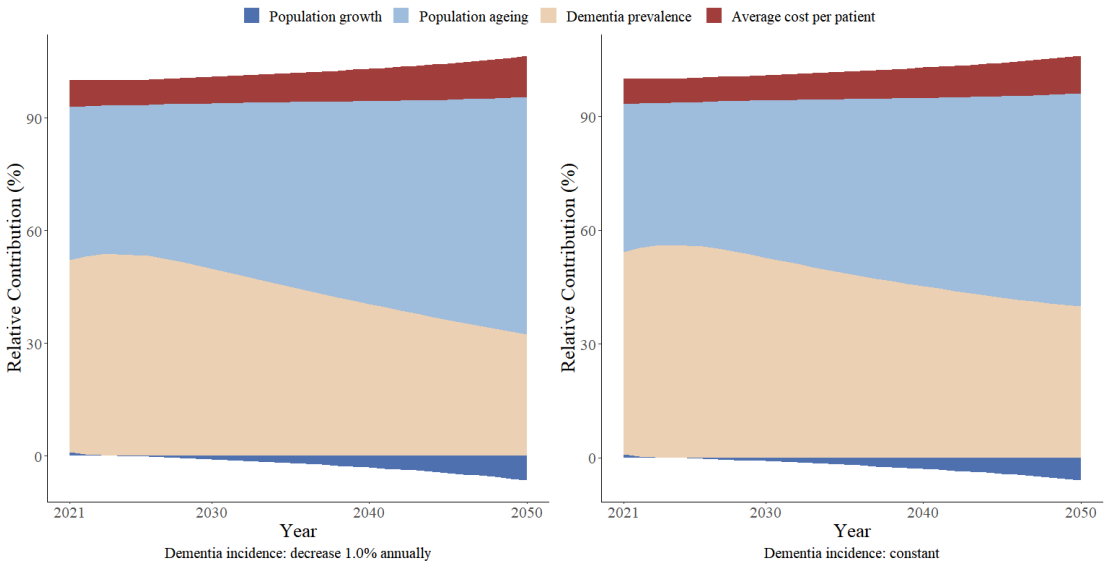

Figure S2 Relative contribution of each factor depending on different temporal trends of dementia incidence

Table S5 Comparison among projection of socioeconomic cost of dementia in China

	Jia-2018[1]	Li-2021[2]	Huang-2022[3]
Main data sources			
Average cost	Self-reported survey mainly based on urban hospitals	Self-reported survey mainly based on urban hospitals	Synthesized individual provincial surveys and previous studies in limited geographical areas
Population	Based on Chan's review[4]	Brookmeyer and Gray's method	Based on Chan's review[4]
Total (billion $)			
2020	248.7	360.9	47.6
2030	507.5	812.4	99.0
2040	1004.3	1582.5	198.8
2050	1890.0	2617.1	368.1
Increase rate (%)			
2020-2030	104.1	125.1	108.0
2020-2050	660	625.2	673.3
Component			
Healthcare (%)	37.1	37.1	7.6
Formal care (%)	9.7	9.7	5.9
Informal care (%)	53.2	53.2	86.5

[1] Jia J *et al*: **The cost of Alzheimer's disease in China and re-estimation of costs worldwide**. *Alzheimers Dement* 2018.

[2] Li F, Qin W, Zhu M, Jia J: **Model-Based Projection of Dementia Prevalence in China and Worldwide: 2020-2050**. *J Alzheimers Dis* 2021.

[3] Huang Y: **Projections of the economic burden of care for individuals with dementia in mainland China from 2010 to 2050**. *PloS one* 2022.

[4] Chan KY*et al*: **Epidemiology of Alzheimer's disease and other forms of dementia in China, 1990–2010: a systematic review and analysis**. *The Lancet* 2013.

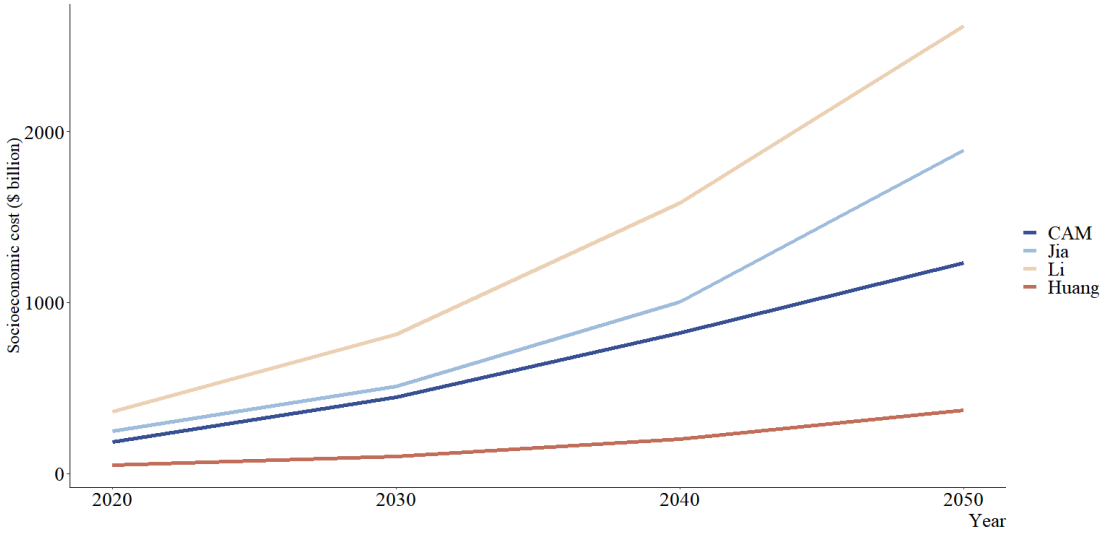

Figure S3 Result comparison of socioeconomic cost of dementia in China

Note. Jia: The cost of Alzheimer's disease in China and re-estimation of costs worldwide. *Alzheimers Dement* 2018; Li: Model-Based Projection of Dementia Prevalence in China and Worldwide: 2020-2050. *J Alzheimers Dis* 2021; Huang: Projections of the economic burden of care for individuals with dementia in mainland China from 2010 to 2050. *PloS one* 2022.