

# Supplementary Material

## Projections of Socioeconomic Costs for Individuals with Dementia in China 2020-2050: Modelling Study

**Supplementary Table 1.** Socioeconomic costs and utility weights for QALYs

	Data sources	Calculation/tools
Healthcare costs	CHARLS	Outpatient + inpatient + treatment
Formal social care costs	CLHLS, CHARLS	Unit price $\times$ probability of formal social care
Informal care costs	CHARLS	Unit price $\times$ informal care time
Utility weights for QALYs	CHARLS	EQ-5D

CHARLS, China Health and Retirement Longitudinal Study; CLHLS, Chinese Longitudinal Healthy Longevity Survey; QALY, quality adjusted life years, EQ-5D, EuroQol five-dimensions questionnaire.

**Supplementary Table 2.** Item construct of EQ-5D in China Health and Retirement Longitudinal Study (CHARLS)

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

Original EQ-5D items and three levels	Questions in CHARLS	Options in CHARLS	Recode three levels
	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	
	<b>Choose the appropriate response refer to how you have felt during the last week.</b>		
<b>Anxiety/ depression</b>	I am not anxious or depressed	I was bothered by things that don't usually bother me.	(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)
	I am moderately anxious or depressed	I had trouble keeping my mind on what I was doing.	
	I am extremely anxious or depressed	I felt depressed.	
		I felt fearful.	
	I felt lonely.		level 1 = (1) level 2 = (2)/(3) level 3 = (4)

**Supplementary Table 3. Summary of transition probability of IMPACT-China Ageing Model (CAM)**

<b>Assumption</b>	<b>Justification</b>
TPs were obtained as a function of age and sex from incident cases between wave n and n+1 of CHARLS, based on pooled data attributing to the survey midpoint. Assumption 1: The age- and sex-specific TPs (equivalent to incidence) of CVD, FI, and cognitive impairment (CI) of CHARLS are similar to those of the whole Chinese population.	TPs are based on representative populations with sampling weights, providing universal estimates for age and sex combinations, encompassing the combined effects of various variables, including education, marital status and region. TPs or incidence of CVD, FI and CI by age and sex were comparable with age- and sex-specific incidence values obtained from external evidence in the mid-point time.
Assumption 2: CVD and non-CVD mortality of the Chinese Longitudinal Healthy Longevity Study (CLHLS) were similar to those of the entire Chinese population from the National Statistical Bureau.	Cause-specific deaths were provided by CLHLS 2002-2005 and 2014-2018. CLHLS is a nationwide aging cohort with an adequate response rate. Survey weight was applied to ensure population representativeness. Deaths predicted by IMPACT-CAM matched with Global Burden of Diseases (GBD) estimates (appendix p 25).
Assumption 3: TPs are considered as a weighted average of the different levels of severity of each disease. Similarly, the survival of people in each health state is assumed to be equivalent to the weighted average survival of people with different severities.	Under the assumption that CHARLS and CLHLS are both population-representative, the observed severity spectrum of conditions (like CVD, or CI) should be proportionate to that of the population. TPs extracted from two cohorts thus represent a weighted average of the severity spectrum of health conditions. Multiplying the weighted average TP by the total number of individuals in a given health state is mathematically equal to the sum of the individual products of severity-specific TPs and the respective population sizes in that health state.
Assumption 4: The model considered the effect of comorbidities such as hypertension, diabetes and BMI, et.al.	Estimates for risks of dementia, CVD, FI and death of CHARLS and CLHLS represent a weighted average of risk levels across the spectrum of severity of these conditions and their comorbidities.

**Supplementary Table 4. GATHER checklist for accurate and transparent health estimates reporting**

Item	Checklist item	Reported on page
<b>Objectives and funding</b>		
1	Define the indicator(s), populations (including age, sex, and geographic entities), and time period(s) for which estimates were made.	3
2	List the funding sources for the work.	1-2
<b>Data Inputs</b>		
<b>For all data inputs from multiple sources that are synthesized as part of the study:</b>		
3	Describe how the data were identified and how the data were accessed.	3-4
4	Specify the inclusion and exclusion criteria. Identify all ad-hoc exclusions.	12, Supp Material
5	Provide information on all included data sources and their main characteristics. For each data source used, report reference information or contact name/institution, population represented, data collection method, year(s) of data collection, sex and age range, diagnostic criteria or measurement method, and sample size, as relevant.	3-6
6	Identify and describe any categories of input data that have potentially important biases (e.g., based on characteristics listed in item 5).	9
<b>For data inputs that contribute to the analysis but were not synthesized as part of the study:</b>		
7	Describe and give sources for any other data inputs.	8-9, Supp Material
<b>For all data inputs:</b>		
8	Provide all data inputs in a file format from which data can be efficiently extracted (e.g., a spreadsheet rather than a PDF), including all relevant meta-data listed in item 5. For any data inputs that cannot be shared because of ethical or legal reasons, such as third-party ownership, provide a contact name or the name of the institution that retains the right to the data.	6-9
<b>Data analysis</b>		
9	Provide a conceptual overview of the data analysis method. A diagram may be helpful.	6-7
10	Provide a detailed description of all steps of the analysis, including mathematical formulae. This description should cover, as relevant, data cleaning, data pre-processing, data adjustments and weighting of data sources, and mathematical or statistical model(s).	6-9
11	Describe how candidate models were evaluated and how the final model(s) were selected.	6-8

<b>Item</b>	<b>Checklist item</b>	<b>Reported on page</b>
<b>12</b>	Provide the results of an evaluation of model performance, if done, as well as the results of any relevant sensitivity analysis.	8
<b>13</b>	Describe methods for calculating uncertainty of the estimates. State which sources of uncertainty were, and were not, accounted for in the uncertainty analysis.	8
<b>14</b>	State how analytic or statistical source code used to generate estimates can be accessed.	6-9
<b>Results and Discussion</b>		
<b>15</b>	Provide published estimates in a file format from which data can be efficiently extracted.	9-10
<b>16</b>	Report a quantitative measure of the uncertainty of the estimates (e.g., uncertainty intervals).	9-10
<b>17</b>	Interpret results in light of existing evidence. If updating a previous set of estimates, describe the reasons for changes in estimates.	10-13 11, Supp Material
<b>18</b>	Discuss limitations of the estimates. Include a discussion of any modelling assumptions or data limitations that affect interpretation of the estimates.	12-13

**Supplementary Table 4.** The distribution of different health states in CHARLS and CLHLS n (%)

	Wave	N	Health	CI	CI & FI	CVD	CVD & CI	CVD & CI & FI	CVD & FI	FI
<b>CHARLS</b>	<b>2011</b>	13671	10456 (76.5)	596 (4.4)	102 (0.7)	1783 (13.0)	146 (1.1)	67 (0.5)	189 (1.4)	332 (2.4)
	<b>2013</b>	15145	11422 (75.4)	675 (4.5)	119 (0.8)	2085 (13.8)	165 (1.1)	81 (0.5)	227 (1.5)	371 (2.4)
	<b>2015</b>	16664	11977 (71.9)	840 (5.0)	127 (0.8)	2638 (15.8)	311 (1.9)	125 (0.8)	246 (1.5)	400 (2.4)
	<b>2018</b>	17467	11007 (63.0)	892 (5.1)	138 (0.8)	3662 (21.0)	564 (3.2)	240 (1.4)	526 (3.0)	438 (2.5)
	<b>2005</b>	13780	8779 (63.7)	483 (3.5)	351 (2.5)	1603 (11.6)	55 (0.4)	241 (1.7)	600 (4.4)	1668 (12.1)
<b>CLHLS</b>	<b>2008</b>	14042	9505 (67.7)	434 (3.1)	336 (2.4)	1597 (11.4)	61 (0.4)	105 (0.7)	453 (3.2)	1551 (11.0)
	<b>2011</b>	8720	5336 (61.2)	224 (2.6)	222 (2.5)	1237 (14.2)	45 (0.5)	118 (1.4)	391 (4.5)	1147 (13.2)
	<b>2014</b>	6509	3927 (60.3)	152 (2.3)	183 (2.8)	978 (15.0)	47 (0.7)	93 (1.4)	341 (5.2)	788 (12.1)
	<b>2018</b>	13575	7988 (58.8)	338 (2.5)	321 (2.4)	2170 (16.0)	93 (0.7)	259 (1.9)	738 (5.4)	1668 (12.3)

**Supplementary Table 5.** Basic characteristics of China Health and Retirement Longitudinal Study 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)
<b>Age (years)</b>								
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)
<b>Gender n (%)</b>								
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)
<b>Total healthcare cost (\$)</b>								
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)
<b>Informal social caregiving time (h/month)</b>								
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)
<b>Informal care cost (\$ /year)</b>								
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)
<b>Utility weights</b>								
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)



**Supplementary Table 6.** Basic characteristics of Chinese Longitudinal Healthy Longevity Survey 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)
<b>Age (years)</b>										
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)
<b>Gender n (%)</b>										
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)
<b>Receipt of formal social care n (%)</b>										
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)
<b>Living in a nursing home n (%)</b>										
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)
<b>Formal social care cost (\$/year)</b>										
Mean (SD)	465 (2380)	2030 (4650)	310 (1960)	1230 (3760)	351 (2080)	857 (3180)	364 (2120)	1420 (4010)	518 (2510)	1700 (4320)

**Supplementary Table 7. Time trend of average cost per patient and aggregate cost of dementia**

Year	dementia cases (N)	Healthcare cost	Formal social care cost	Informal care cost	Aggregated socioeconomic costs	Cost of QALY lost
Average cost per patient (\$)						
2020	12.1	4011.3 (3147.5, 4770.6)	502.6 (395.4, 599.0)	10878.2 (8543.3, 12947.3)	15392.1 (12086.2, 18316.9)	10433.3 (10421.5, 10445.2)
2030	26.8	4476.9 (3513.4, 5325.2)	565.9 (446.1, 674.4)	11586.9 (9098.9, 13800.0)	16629.7 (13058.4, 19799.6)	10593.9 (10574.1, 10613.2)
2040	46.6	4909.6 (3852.2, 5839.8)	608.0 (479.0, 725.4)	12170.4 (9558.0, 14488.6)	17688 (13889.2, 21053.8)	10630.6 (10612.2, 10649.2)
2050	66.3	5324.8 (4177.2, 6333.4)	633.6 (498.7, 755.6)	12608.1 (9903.9, 15020.8)	18566.5 (14579.8, 22109.8)	10586.0 (10568.1, 10604.3)
Aggregate cost (billion \$)						
2020	12.1	48.4 (38.0, 57.8)	6.1 (4.8, 7.2)	131.4 (103.0, 156.8)	185.9 (145.8, 221.8)	126.0 (123.9, 128.1)
2030	26.8	119.9 (94.2, 142.9)	15.2 (12.0, 18.1)	310.5 (244.1, 370.0)	445.6 (350.3, 531)	283.6 (276.8, 290.3)
2040	46.6	228.7 (178.8, 271.9)	28.3 (22.2, 33.8)	566.9 (443.1, 674.9)	823.9 (644.1, 980.6)	495.0 (483.6, 507.5)
2050	66.3	353.4 (276.2, 421.1)	42.1 (32.9, 50.2)	837.6 (653.8, 997.3)	1233.1 (962.9, 1468.6)	702.1 (685.3, 719.8)

**Supplementary Table 8.** Comparison among projection of socioeconomic cost of dementia in China.

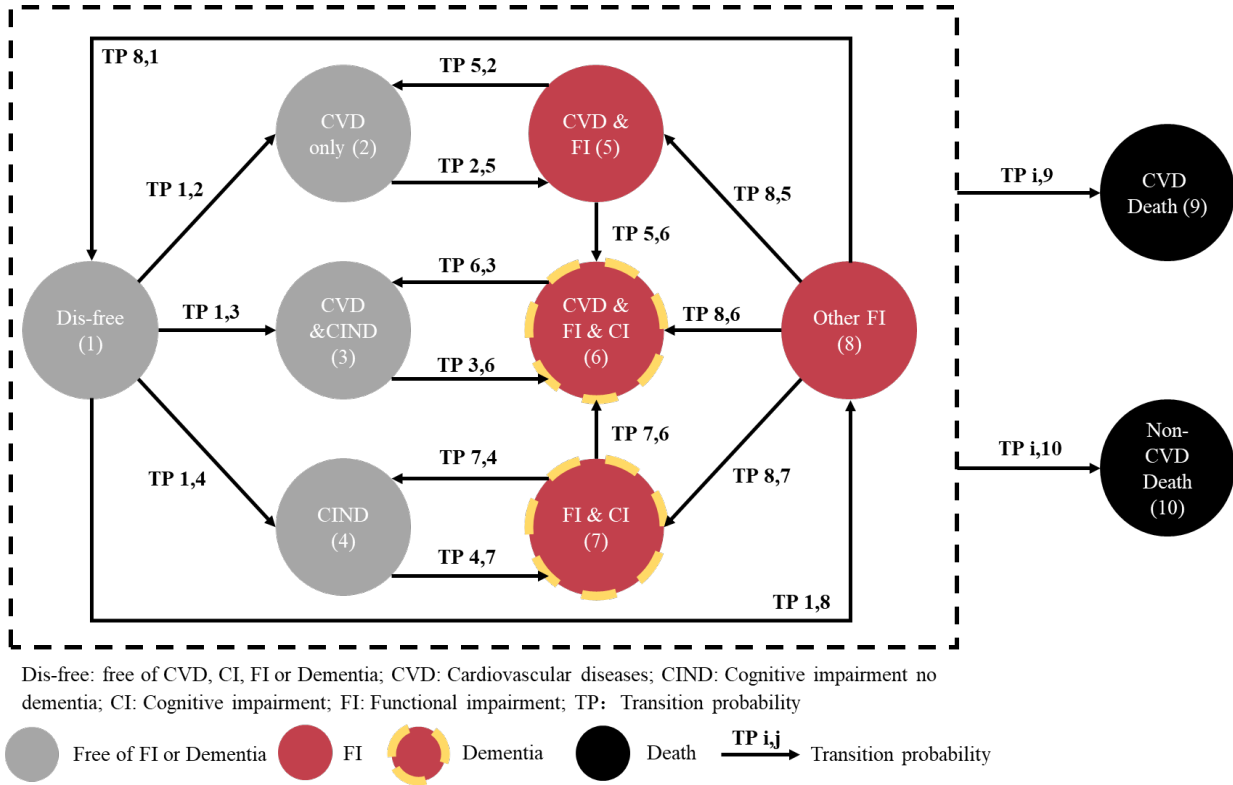
	<b>Jia-2018<sup>1</sup></b>	<b>Li-2021<sup>2</sup></b>	<b>Huang-2022<sup>3</sup></b>
Main data sources			
Average cost	Self-reported survey mainly on urban hospitals	Self-reported survey mainly based on urban hospitals	Synthesized individual provincial surveys and previous studies in limited geographical areas
Population	Based on Chan's review <sup>4</sup>	Brookmeyer and Gray's method	Based on Chan's review <sup>4</sup>
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 social care (%)	9.7	9.7	5.9
Informal care (%)	53.2	53.2	86.5

<sup>1</sup>Jia J, Wei C, Chen S, et al. The cost of Alzheimer's disease in China and re-estimation of costs worldwide. *Alzheimers Dement* 2018; 14: 483-491.

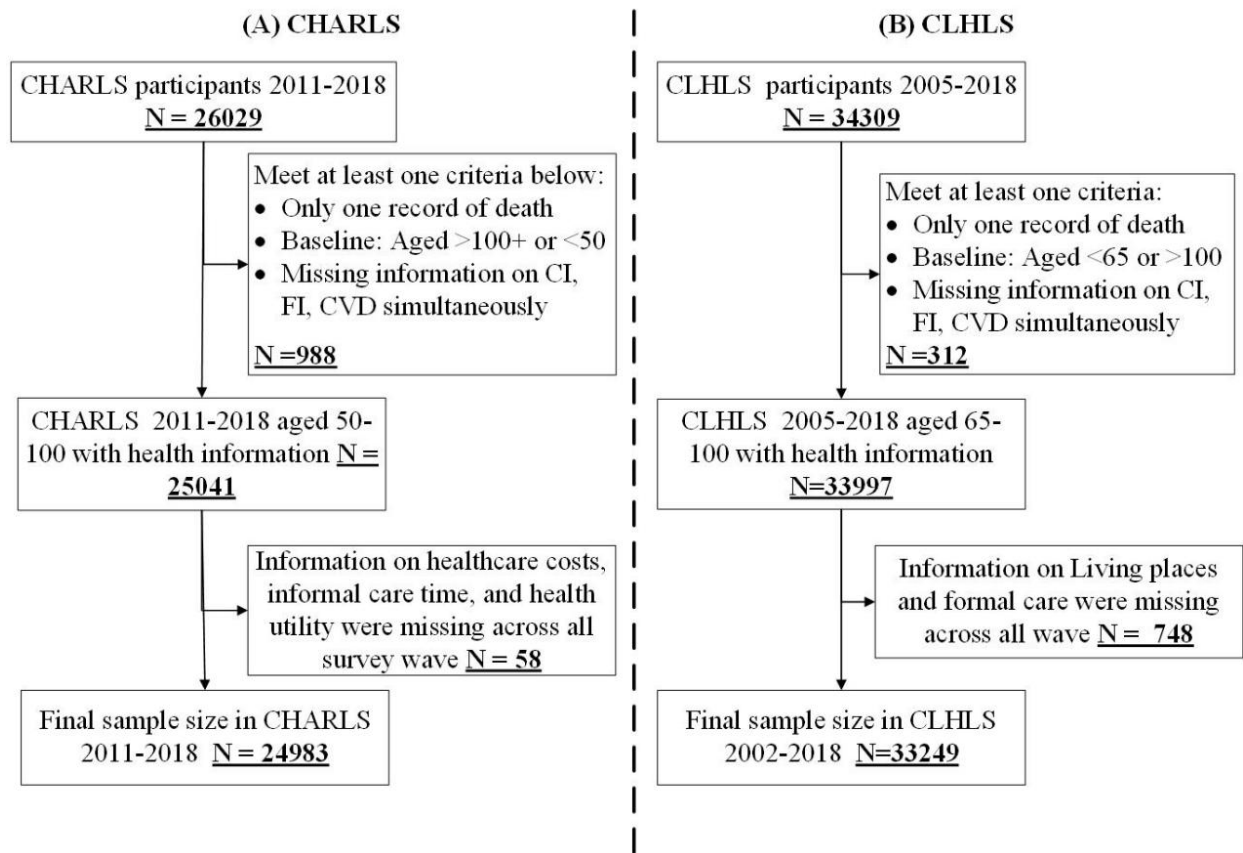
<sup>2</sup>Li F, Qin W, Zhu M, et al. Model-based projection of dementia prevalence in China and worldwide: 2020-2050. *J Alzheimers Dis* 2021; 82: 1823-1831.

<sup>3</sup>Huang Y, Li X, Liu Z, et al. Projections of the economic burden of care for individuals with dementia in mainland China from 2010 to 2050. *PLoS One* 2022; 17: e0263077.

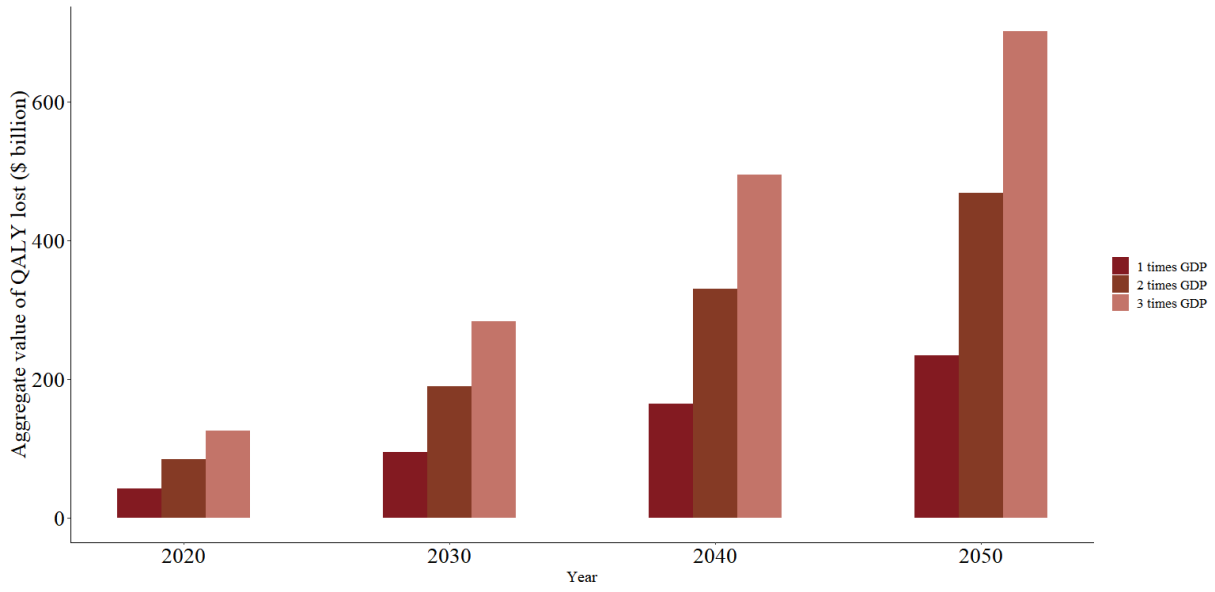
<sup>4</sup>Chan KY, Wang W, Wu JJ, et al. Epidemiology of Alzheimer's disease and other forms of dementia in China, 1990-2010: a systematic review and analysis. *Lancet* 2013; 381: 2016-2023.



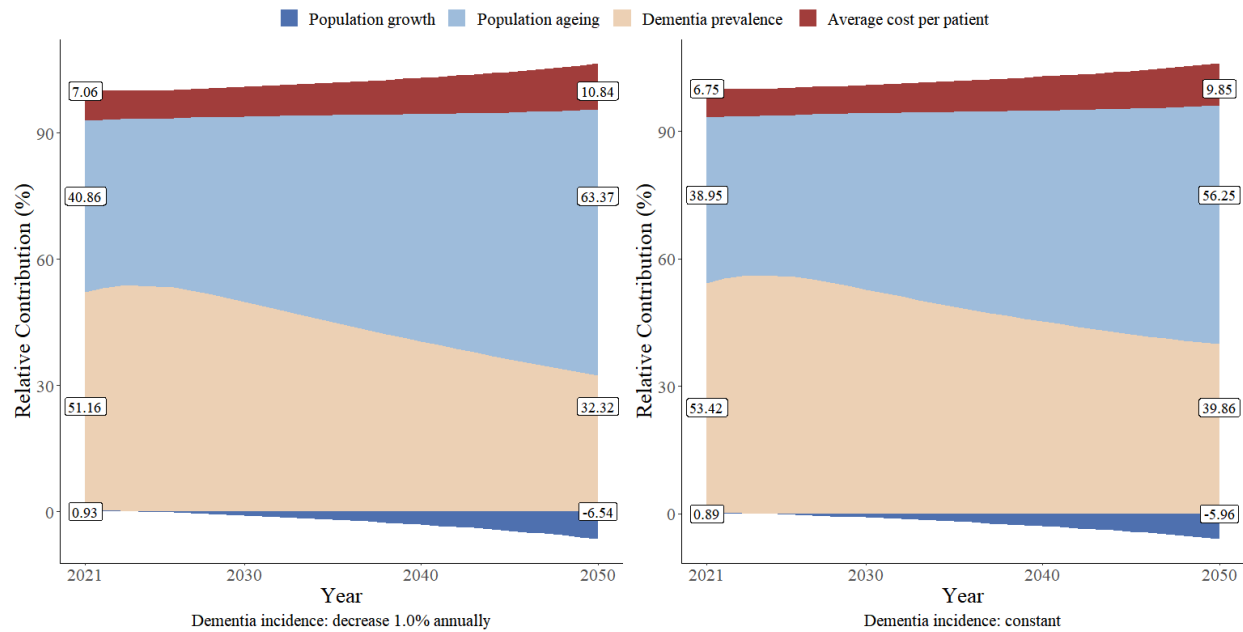
**Supplementary Figure 1. IMPACT-CAM structure**



**Supplementary Figure 2.** Sample selection flowchart for CHARLS and CLHLS.



**Supplementary Figure 3.** Aggregate value of QALY lost based on different values of one QALY



**Supplementary Figure 4. the relative contribution of each driver for different trends of dementia incidence.** Decomposition of change in aggregate socioeconomic costs (%) of dementia in China between 2020 (ref) to 2050. Population growth, population ageing (aged 50+ years), dementia prevalence and average socioeconomic cost per patient under alternative constant (0%) or decrease (-1.0%) assumptions. Estimates for population growth are derived from the total population size from 2020 to 2050, of the United Nations (aged 0+). Population ageing equals to population size in each age, sex group divided by total population size (aged 50+). Dementia prevalence equals to the number of dementia cases divided by population size in each age, sex group (aged 50+). Average costs per case is the aggregate socioeconomic costs (i.e., healthcare cost, formal social care and informal care costs) divided by the number of dementia cases (aged 50+).