Projection of Older Adults with Disability under the Demo-Socio-Economic Factors in China, 2006-2050

Authors
Lei Zhang, PhD[1], Xiaoying Zheng, PhD[1],

1 Institute of Population Research, Peking University, China

Correspondence:
Prof. Xiaoying Zheng
Address: Institute of Population Research/WHO Collaborating Center on Reproductive Health and Population Science, Peking University, Beijing 100871, China
E-mail: xzheng@pku.edu.cn
Tel: +86-10-62759185
Fax: +86-10-62751976

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Abstract

Background: Population ageing, combined with the fact that disability is most common among the elderly, has focused attention on the future changing of ageing population with disability. While populations throughout the world are ageing rapidly, China already has one of the largest ageing populations who met a big challenge on burden of disability. ***Objectives:*** This study creates a new model to predict the changing tendency of ageing population with disability, and determines whether demographic, social, and economic factors could account for the tendency, and finally gives some evidences on prevention and reduction of disability risk. ***Data & Methods:*** A cross-sectional data of Second China Sample Survey on Disability (2006) is used in this study, it covered total 31 provinces, Municipalities and Autonomous Regions, with the sample size of 2526145 (161479 were disabled persons), and six types of disability were included. This study combines PDE (Population and Environment) model with the methods of static covariate-direct prediction, static covariate by type prediction and dynamic covariate effect prediction respectively. ***Results:*** The future total number and growth rate of older adults with disabilities in China are very striking. Under scenario II, about 1.5 million of older adults increase annually from 2006 to 2040, and more than 2.5 million increase annually from 2040 to 2050. Total number in 2050 is 3.05 times of 2006. And population ageing, sex, place of residence, marital status, education, income, provincial GDP per capita are significantly affect the prevalence of disability among the older adults. ***Discussion***： The huge size of the population with disability in China will bring social economic environment and health care system a tremendous pressure and burden. And China's population will experience a process of population with disability aging and aging population disabling in the future. ***Conclusion***： Social and economic factors affect the development process of future changes in size of population with disability, but the most far-reaching impact factor is population aging, so the health expectancy of the elderly population is most worthy of attention. Well education background and economic environment contribute to the reduction of disability risk, which can be used as the primary factor in disability prevention and control.

Key words: older adults, disability, Demo-Socio-Economic Factors, China

Introduction

Population aging, triggered by a rise in life expectancy and a decline in fertility rates, is a common feature of developed countries[1,2]. China is the most populous country in the world. Over recent years, China has experienced rapid economic growth and increased life expectancy too[3,4]. While the population can, on the whole, look forward to longer years of good health, many people will be living with one or more chronic conditions, which mostly related to disability[5,6]. On the contrast, increasing longevity may be a more complex issue for some people already with disabilities than that of the general population since it has been suggested that the ageing process starts earlier for them[7,8].

A three-component model defines the successful ageing which can be described as avoiding disease by taking preventive measures, minimizing risks for disability, having good cognitive and physical function and engaging in life[9],[10], which advocated a healthy life for ageing population. But actually, disability which causes dependency and institutionalization had been a common problem that impacts the health and life quality of older adults11.

Reported by the Sixth National Population Census Data Bulletin, that at 0:00 on Nov. 1, 2010, China had a total population of 1,339,724,852 in 31 mainland provinces, autonomous regions and municipalities, the population aged 60 years and older accounted for 13.26%. Today's older adult population will be with us tomorrow, and population aged 15-59 in China had already exceeded 930 million who will enter the ageing stage in the future 45 years[12], which indicates a huge potential burden on health care and economic development[13].

Population ageing, combined with the fact that disability has focused attention on the future changing of ageing population with disability[14],[15][16],[17],[18],[19],[20]. And many researchers have explored the factors that affect status of disability on older individuals in western countries [21], [22]. Compared with those countries emerging a declining tendency of prevalence rate for chronic disability in older population over the past decade, such as the U.S.A.[23] and Japan[15], we know less about the trends of China who has the most older adults of the world.

As disability in the older age groups would have far-reaching effects on the well-being of individuals and society as a whole[24,25,26], this research trying to address the gap and analyze the changing tendency of the size and structure of ageing population with disability based on determining the probable demographic, social and economic risk factors account for the tendency.

Conceptual framework

Health outcomes can be divided into healthy, with disease, with disability and death[27], and the process of each outcomes change to the other is affected by the individuals' living conditions, which includes genetic, demographic, economic, social and natural environmental factors[28],[29], just like figure 1 shows. In China, all above factors have the regional characteristics because of the huge disparity between urban

and rural environments, and provincial unbalanced development. Same factor in different region may cause different health outcomes and different strength and direction on health outcomes[30],[31].

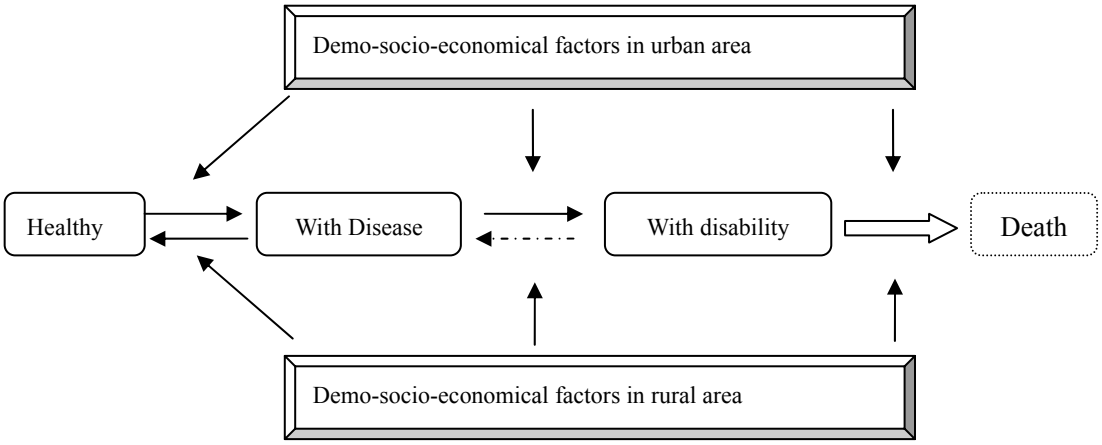

Fig.1 Conversion of health status dynamic

In this analysis, projection of older adults with disability is based on total population projection and prevalence rate of disability. From health status perspective, total population can be divided into 4 outcomes[29], and in our analysis, we have to consider the prevalence rate of disability by taking full account of current demo-socio-economic changes, but also to the simplicity of projection model. Then, disease and death were filtered and here we only divided the total population into population with disability and without disability. Figure 2 shows how the population size of different health status change in a region. Immigrants and new born babies will increase a population size, while the emigration and death will decrease the size. Beside the congenital reasons, the decline of human being's physical function[32], living environment changes, accidents et al [28-32] make people get permanent or temporary disability, and as the progress in medical conditions, and improvement of individual economic conditions, some of disability in the early detection and early treatment had been cured[33], [34].

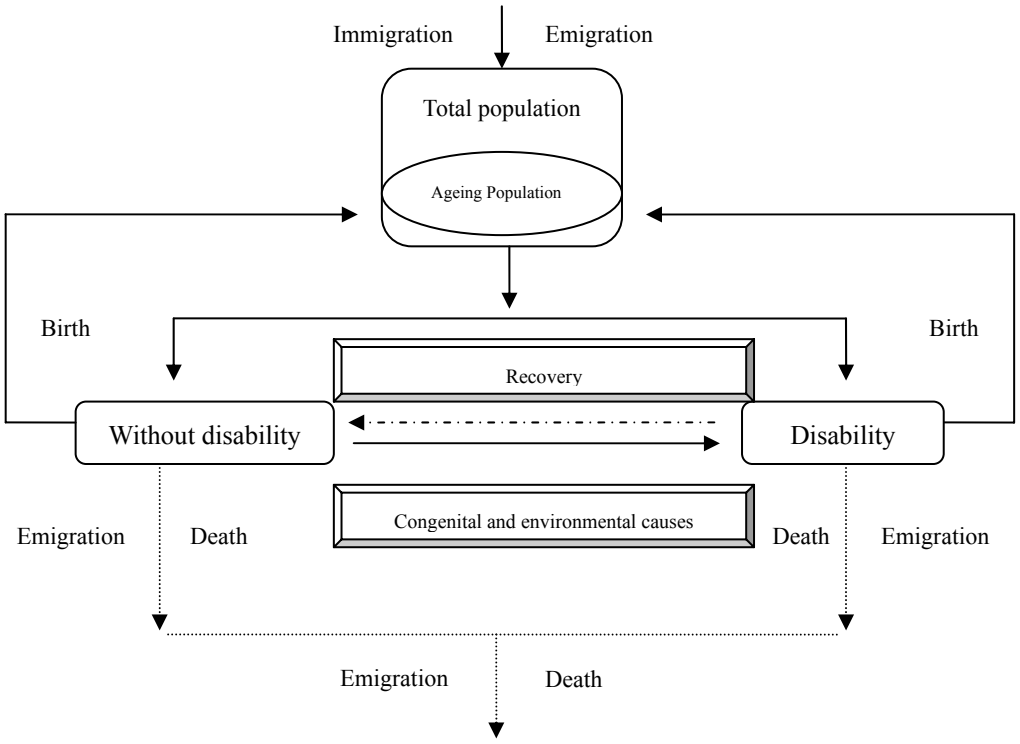

Fig. 2 Population changes dynamic by different health status

Therefore, the projection of population with disability would have two models (1) projection model of total population; (2) projection model of prevalence rate of disability. Combined with the outcomes of two models, the size and structure of ageing population with disability would be gotten. And our analysis put the emphasis on the status conversion of without disability to disability.

Data and Methods

Sample and data

The data used in the analysis based on the Second China National Sample Survey on Disability, a population-based, nationally representative survey conducted from April 1, to May 30, 2006 in China. With the approval of the State Council of the People's Republic of China, the Leading Group of the Second China National Sample Survey on Disability conducted the survey. All participants completed informed consents given by the Chinese government.

Only household residence people lived in the sampled community were interviewed, while institutionalized people were not included. The sample survey was a stratified, multiphase and cluster probability sampling design, and covered 31 provinces, autonomous regions and municipalities in China, which of four levels of sampling frame including county, town, village and community.

734 counties which accounts for 20% of all counties, were sampled. Then a total of 5964 communities from 2980 towns in 734 counties were sampled, with an average of 420 persons in each community. Post-survey quality checks showed that the

omission rate of the resident population was 1.31‰, the omission rate of the disabled population was 1.12‰, and accuracy was greater than 95%[35].

A total of 2,526,145 non-institutionalized people participated in the survey; 354,859 of them aged 60 and older; 161,479 people had been identified as disability, and among them 85,260 were aged 60 and older.

All data were entered into a custom-designed database and analyzed using SPSS Version 16.0.

Measures

Disability

Implementation of the ICF started in 2001 with the unanimous endorsement of the classification by the 54th World Health Assembly as the framework for describing and measuring health and disability. Since then, ICF has been applied in a variety of settings at national and international level[36.] Disability measured in the Second China National Sample Survey on disability as abnormity of body function and structure, which is essentially "impairment". In clinical settings ICF is used for functional status assessment, goal setting & treatment planning and monitoring, as well as outcome measurement. There were six types of disability classified, which included visual disability, hearing disability, speech disability, physical disability, mental deficiency and psychiatric handicap[37].

Table 1 Main reasons of six types of disability

Type	Main reasons		
Visual disability	01. Hereditary, congenital abnormality or maldevelopment 02. Cataract 03. Glaucoma 04. Trachoma	05. Ceratonosus 06. Optic neuropathy 07. Retinopathy and pigment choroidopathy 08. Ametropia	09. Amblyopia 10. Injury 11. Toxicosis 12. Others 13. Unknown reasons
Hearing disability	01. Hereditary 02. Pregnancy viral infection 03. Infectious disease 04. Autoimmunity defect disease	05. General disease 06. Tympanitis 07. Presbycusis 08. Premature birth and low body weight 09. Asphyxia neonatorium	10. Hyperbilirubinemia 11. Drug intoxication 12. Wound or accident 13. Noise and knocking 14. Others 15. Unknown reasons
Speech disability	01. Mongolism 02. Brain paralysis 03. Pathological jaundice 04. Premature birth, low body weight and late birth 05. Cleft palate 06. Mental retardation 07. Cerebral infarction	08. Cerebral hemorrhage 09. Cephalitis 10. Cerebral cysticercosis 11. Larynx and lingua disease after surgery 12. Hearing handicap 13. Parkinson's disease 14. Multiple sclerosis	15. Lateral spinal sclerosis 16. Brain trauma 17. Birth trauma 18. Autism 19. Epilepsy 20. Co-poisoning 21.Others 22.Unknown reasons
Physical disability	01. Brain paralysis 02. Maldevelopment 03. Dwarfism 04. Other congenital abnormalities or maldevelopment 05. Polio 06. Cerebrovascular disease 07. Surrounding blood vessel disease	08. Tumor 09. Osteoarthrosis 10. Local diseases 11. Diseases of spinal cord 12. Working injury 13. Traffic accident 14. Spinal cord injury	15. Brain trauma 16. Other traumas 17. Tuberculosis infection 18. Pyogenic infection 19. Toxicosis 20. Others 21. Unknown reasons
Mental deficiency	01. Hereditary 02. Brain disease 03. Dyshormonism 04. Eclampsia disease 05. Fetal and neonatal asphyxia 06. Premature birth, low body weight and late birth	07. Developmental deformity 08. Malnutrition 09. Pregnancy trauma and physical injury 10. Birth trauma 11. Working injury 12. Traffic accident	13. Other kinds of injury 14. Toxicosis and anaphylactic reaction 15. Unhealthy social and cultural factors 16. Others 17. Unknown reasons

Psychiatric handicap	01. Dementia 02. Other organic disorders 03. Mental active material caused disorders 04. Schizophrenosis 05. Delusion disorder	06. Fissile affective disorder 07. Other mental disease disorder 08. Mood disorder 09. Neurosis disorder 10. Behavior syndrome	11. Personality disorder 12. Autism 13. Epilepsy 14. Others 15. Unknown reasons

Variables definition and recoding

In the analysis variables related to demographic, social and economic status were included, such as sex, age, education, marital status, place of residence, nationality, occupation, employment, income, and GDP per capita. For statistical consideration, some of the variables were recoded. Sex was recoded as 1 (male) or 0 (female). Place of residence was recoded as 1 (urban) or 0 (rural). Nationality was recoded as 1 (Han nationality), or 0 (other nationalities). Employment was coded as 1 (currently employed) or 0 (currently unemployed). Marital status, education, per capita household income were recoded to dummy variables. Using the standard of China National 1% Population Sample Survey in 2005, 683-944 yuan was classified as a measurement of relative poverty level in rural area[38]; 7254 yuan and 2948 yuan are the means of per capita household income in urban and rural areas respectively result from the Second China National Sample Survey on disability in 2006. Provincial GDP per capita were based on information from the China Statistical Yearbook (2006). Occupation was recoded into seven dummy variables: type I, Leaders of government agencies, party and mass organizations, enterprises and institutions; type II, natural/ social scientific and technical staff; type III, commercial and service staff; type IV, workers of agriculture, forestry, animal husbandry, fisheries and water conservancy production; type V, Production workers or operators of prospecting, mineral mining, metal smelting, machinery, electronic components, rubber production, wood processing, building materials, film and television; type VI, Transport equipment operators; and type VII, other can not be clearly defined.

Analytical method

Traditional population projections basically require three parameters that are fertility, mortality and migration[39.] In this study, we selected the results of population projection by using PDE model which considered 4 parameters in it, which means to predict a birth cohort by taking into account the net migration and educational status of sub-regional (urban, rural) population in addition to the parameters of fertility and mortality [40,41,42].

Besides, binary logistic regression analysis is used to make projection of older adults with disability, which conducted for prevalence rate of disability forecasting. The original formula of logistic regression is:

$$P = \frac{L}{1 + \exp[-(a + bt)]}$$

a complex formula is required to convert back and forth from the logistic equation to the OLS-type equation.

$$p = \frac{1}{1+\exp[-(a+bx)]}$$

In order to simplify the model, make $z = a + bx$, then:

$$p = \frac{1}{1+\exp(-z)} = \frac{\exp(z)}{1+\exp(z)}$$

$$p[1+\exp(z)] = \exp(z)$$

$$p + p*\exp(z) = \exp(z)$$

$$p = (1-p)\exp(z)$$

$$\frac{p}{1-p} = \exp(z)$$

$$\ln[\frac{p}{(1-p)}] = z$$

The logistic formulas are stated in terms of the probability that Y = 1, which is referred to as $p = p$ （$y = 1$） . The probability that Y is 0, is $1-p = 1-p$ （$y = 1$） $= p$ （$y = 0$） The ln symbol in $\ln[\frac{p}{(1-p)}] = z$ refers to a natural logarithm and z is our familiar equation for the regression line. *p* can be computed from the regression equation also. So, if we know the regression equation, we could, theoretically, calculate the expected probability that Y = 1 for a given value of x.

And z=$a + bx$ can be used in multiple independent variables analysis, which is z=$a + b_1x_1 + b_2x_2 + ... + b_kx_k$. Here x_i can be as the demo-socio-economic variables, and *p* represents the prevalence rate of disability.

Scenarios for projection

Total population considered 4 parameters, and the scenarios are as table 5 shows, and finally the middle scenario will be used for older adults projection.

Table 5 Scenarios of Total Fertility Rate, Life Expectancy and net migration in total population projection

TFR	**Year of 2000**	**Low scenario** **1.66**	**Middle scenario** **1.8**	**High scenario** **2.0**
Urban	1.28	1.28 （by 2050）	1.37 （by 2050）	1.53 （by 2050）

Rural	1.95	1.95 （by 2050）	2.11 （by 2050）	2.30 （by 2050）
LE (Years)	Urban (male)	Urban (female)	Rural (male)	Rural (female)
Year of 2000	73.5	77.39	68.89	72.09
Year of 2010	74.55	78.86	69.87	73.46
Year of 2020	75.60	80.34	70.86	74.84
Year of 2030	76.65	81.81	71.84	76.21
Year of 2040	77.70	83.28	72.82	77.58
Year of 2050	78.75	84.76	73.81	78.96
Net migration	Low		High	
Size	The size of net migration in each of the future years keep constant with the level in 2000		The size of net migration both in urban and rural area account for 10% of the total population in each of the future years	

Source of the data in 2000: Composed by Population Census Office of State Council and Population, social and technological division, National Bureau of Statistics of China. Major figures on 2000 Population Census in China. China Statistics Press, 2001.

Table 6 Scenarios of educational transition rate by age

illiterate-primary	2000				2030-2050			
	Urban		Rural		Urban		Rural	
Age	male	female	male	female	male	female	male	female
6	0.7855	0.7919	0.8150	0.7954	0.8150	0.7954	0.8150	0.7954
7	0.9803	0.9784	0.9637	0.9526	0.9803	0.9784	0.9803	0.9784
8	0.9942	0.9932	0.9847	0.9774	0.9942	0.9932	0.9942	0.9932
9	0.9949	0.9944	0.9893	0.9843	0.9949	0.9944	0.9949	0.9944
10	0.9874	0.9860	0.9672	0.9490	0.9874	0.9860	0.9874	0.9860
11	0.9889	0.9878	0.9706	0.9532	0.9889	0.9878	0.9889	0.9878
12	0.9888	0.9875	0.9689	0.9491	0.9888	0.9875	0.9888	0.9875
13	0.9892	0.9876	0.9698	0.9490	0.9892	0.9876	0.9892	0.9876
14	0.9885	0.9866	0.9661	0.9412	0.9885	0.9866	0.9885	0.9866
Primary –middle school	2000				2030-2050			
	Urban		Rural		Urban		Rural	
age	male	female	male	female	male	female	male	female
10	0.0125	0.0144	0.0091	0.0088	0.0125	0.0144	0.0125	0.0144
11	0.1173	0.1338	0.0700	0.0694	0.1173	0.1338	0.0937	0.1016
12	0.5326	0.5705	0.3253	0.3199	0.5326	0.5705	0.4290	0.4452
13	0.9960	1.0073	0.7170	0.6886	0.9960	1.0073	0.8565	0.8479
14	1.1685	1.1580	0.9443	0.8881	1.1685	1.1580	1.0564	1.0231
15	0.8870	0.8696	0.7235	0.6479	0.8870	0.8696	0.8053	0.7588
16	0.9215	0.9013	0.7622	0.6783	0.9215	0.9013	0.8419	0.7898
17	0.9294	0.9113	0.7697	0.6861	0.9294	0.9113	0.8495	0.7987

18	0.9274	0.9124	0.7619	0.6826	0.9274	0.9124	0.8447	0.7975
19	0.9204	0.9042	0.7428	0.6640	0.9204	0.9042	0.8316	0.7841
Middle school-college	2000				2030-2050			
	Urban		Rural		Urban		Rural	
Age	male	female	male	female	male	female	male	female
15	0.0068	0.0140	0.0002	0.0003	0.0136	0.0280	0.0003	0.0005
16	0.0199	0.0311	0.0005	0.0008	0.0397	0.0621	0.0010	0.0015
17	0.0659	0.0736	0.0018	0.0022	0.1317	0.1473	0.0036	0.0044
18	0.2600	0.2548	0.0061	0.0065	0.5201	0.5095	0.0123	0.0129
19	0.4810	0.4231	0.0118	0.0111	0.9621	0.8461	0.0235	0.0223
20	0.1450	0.1254	0.0183	0.0200	0.2900	0.2508	0.0366	0.0399
21	0.1769	0.1408	0.0448	0.0644	0.3538	0.2815	0.0897	0.1288
22	0.1710	0.1298	0.0565	0.0776	0.3420	0.2597	0.1131	0.1552
23	0.1478	0.1213	0.0751	0.1166	0.2955	0.2426	0.1503	0.2333
24	0.1321	0.1202	0.0949	0.1471	0.2642	0.2942	0.1898	0.2942

Source of the data in 2000: Composed by Population Census Office of State Council and Population, social and technological division, National Bureau of Statistics of China. Major figures on 2000 Population Census in China. China Statistics Press, 2001.

Base on the regression model for prevalence rate of disability projection, proportion of older adults, education structure, average proportion of the employed and average per capita of household income should be made scenarios as their possible development path.

In the study, disability prevalence by “sex” and “educational level” were kept as the level of base year 2006, for educational level had been regarded as a parameter of total population projection. And sex ratio at birth had also been assumed in the total population projection.

The average proportion of older adults was 11.46% base on the total population projection. In the base year of sample survey on disability in 2006, average per capita household income in urban and rural areas were 7254RMB and 2948 RMB; and average proportion of the employed were 58.73% and 53.39% respectively.

China's social and economic environment changes very fast[3,4], the gap of average per capita household income between urban and rural were widening over the past three decades[43]. Adjustment of division of administrative areas was quite frequent since 1997 in china, from 2003 till now, the provincial urban and rural administrative divisions stay relatively stable[44]. Base on the data of disposable income of urban residents and per capita net income of rural residents publicized by National Bureau of Statistics of China from 2003-2009, the following equation was got and as the scenario of future changing of income[45].

$$X_i = X_{i-1}(1+r)^n$$

X_i represents the disposable income of urban residents or per capita net income of rural residents in year i, r represents the growth rate from year i-1 to i, and n

represents the interval of the year. According to the data calculated from the information of National Bureau of Statistics, $r_{urban} = 0.11$, and $r_{rural} = 0.12$.

All along, China use registered unemployment rate as a statistical indicator to measure the unemployed population living in urban area, those who live in rural area working in agriculture were not included. Therefore, this study based on the survey content, choose age specific proportion of the employed as a projection parameter, and make a scenario of keeping the base year level as a maximum in the future 40 years.

In summary, two scenarios for the main parameters in the model of older adults with disability projection:

Scenario I, keep the independent variables maintain the base level of 2006 until 2050.

Scenario II, make the following independent variables dynamically changes as table 7 shows. And other variables were kept as the level as the base year of 2006.

Table 7 Scenarios of average proportion of older adults (%) and Average per capita household income (RMB yuan)

Year	Average proportion of older adults (%)	Average per capita household income (RMB yuan)	
		Urban	Rural
2006	11.46	7254	2948
2010	12.95	11012	4639
2020	17.52	31268	14407
2030	25.32	88783	44747
2040	29.95	252092	138976
2050	35.95	715795	431639

Results

Correlates between disability and demo-socio-economic factors

As table 2 shows, in binary analysis among the older people, the following emerged as significant predictors of disability: age (80+, OR=5.79; 70-79, OR=2.51; 60-69, OR=1.0), sex (male, OR=1.07; female, OR=1.0), residence (urban, OR=0.76; rural, OR=1.0), education (never attend school, OR=3.39; primary school, OR=2.03; high/middle school, OR=1.37; college, OR=1.0), employment (currently not employed, OR=2.95; currently employed, OR=1.0), nationality (Han, OR=1.08; other , OR=1.0), marriage status (unmarried, OR=2.97; divorced, OR=1.53; widowed,

OR=2.03; married, OR=1.0), income (≤683, OR=2.47; 684-944, OR=2.13; 945-2948, OR=1.69; 2949-7254, OR=1.33; ≥7255, OR=1.0), GDP per capita(≤10 thousand, OR=1.37; 10 thousand – 30 thousand, OR=1.30; >30 thousand, OR=1.0).

In binary analysis among total population, the following emerged as significant predictors of disability: age(60+, OR=20.34; 15-59, OR=2.67; 0-14, OR=1.0); sex (male, OR=0.97; female, OR=1.0), residence (urban, OR=0.74; rural, OR=1.0), education (never attend school, OR=10.63; primary school, OR=3.99; high/middle school, OR=1.72; college, OR=1.0), employment (currently not employed, OR=6.89; currently employed, OR=1.0), nationality (Han, OR=0.97; other , OR=1.0), marriage status (unmarried, OR=0.50; divorced, OR=2.22; widowed, OR=6.00; married, OR=1.0), income (≤683, OR=4.95; 684-944, OR=3.42; 945-2948, OR=2.23; 2949-7254, OR=1.36; ≥7255, OR=1.0), GDP per capita(≤10 thousand, OR=1.19; 10 thousand – 30 thousand, OR=1.11; >30 thousand, OR=1.0), occupation(type I, OR=11.90; type II, OR=0.68; type III, OR=0.98; type IV, OR=1.42; type V, OR=3.01; type VI, OR=0.97; type VII, OR=2.09).

Table 2 Prevalence of disability among Chinese total population and older adults

Variables		Total population			Older adults		
		Sample size	prevalence	OR (95% CI)	Sample size	prevalence	OR (95% CI)
Age							
	60+	85260	24.03	20.336(19.856,20.828)			
	15-59	68650	4.06	2.674(2.611,2.738)			
	0-14	7569	1.58	1.0			
	80+				19056	49.70	5.791(5.657,5.929)
	70-79				37279	30.28	2.513(2.470,2.557)
	60-69				28925	14.96	1.0
Gender							
	male	83342	6.51	0.965(0.956,0,975)	40321	23.46	1.073(1.056,1.089)
	female	78137	6.27	1.0	44939	24.56	1.0
Residence							
	Urban	44783	5.29	0.735(0.726,0.743)	25222	20.52	0.755(0.742,0.768)
	rural	116696	6.95	1.0	60038	25.88	1.0
Nationality							
	Han	142870	6.41	0.972(0.955,0.988)	76676	23.83	1.075(1.046,1.105)
	other	18609	6.25	1.0	8584	25.97	
Education							
	Never attended school	74292	15.34	10.631(10.148,11.138)	48726	30.84	3.386(3.175,3.611)
	Primary school	51050	6.50	3.988(3.806,4.179)	25156	21.10	2.026(1.898,2.162)
	Middle school	33846	3.00	1.716(1.637,1.799)	10005	15.23	1.368(1.280,1.464)
	College and above	2291	1.77	1.0	1373	11.50	1.0
Marital status							

	Unmarried	26722	3.17	0.495(0.488,0.501)	2062	42.59	2.966(2.803,3.138)
	Divorced	2931	12.33	2.224(2.136,2.316)	591	26.99	1.532(1.390,1.689)
	widowed	37913	28.09	6.003(5.923,6.084)	35238	33.04	2.028(1.995,2.061)
	Married	93913	6.16	1.0	47369	19.64	1.0
Employment							
	Currently not employed	54321	2.89	6.894(6.821,6.968)	11558	12.30	2.950(2.890,3.011)
	Currently employed	107158	16.52	1.0	73702	28.25	1.0
Income							
	⩽683	18062	14.05	4.950(4.833,5.070)	9831	33.56	2.470(2.389,2.555)
	684-944	10937	10.57	3.420(3.330,3.513)	5770	30.59	2.134(2.053,2.218)
	945-2948	77234	7.41	2.228(2.185,2.271)	38193	25.85	1.693(1.649,1.739)
	2949-7254	40737	4.75	1.361(1.333,1.389)	21591	21.48	1.333(1.296,1.371)
	⩾7255	14509	3.67	1.0	9875	16.91	1.0
GDP Per capita (yuan)							
	⩽10000	48270	6.75	1.187(1.152,1.223)	25302	25.55	1.366(1.310,1.425)
	10000-30000	100489	6.32	1.111(1.079,1.144)	52215	24.03	1.296(1.244,1.350)
	>30000	12720	5.76	1.0	7743	20.08	1.0
Occupation							
	Type I	107323	16.03	11.900(11.623,12.185)			
	Type II	821	1.08	0.680(0.633,0.731)			
	Type III	949	1.55	0.982(0.918,1.052)			
	Type IV	3872	2.23	1.424(1.370,1.481)			
	Type V	36212	4.60	3.006(2.931,3.082)			
	Type VI	3812	1.52	0.965(0.927,1.003)			
	Type VII	921	3.25	2.092(1.952,2.243)			

Risk factors analysis

Results of Binary logistic regression showed that most of the socio-economic-demographic factors were significantly associated with disability among total population except nationality ($p \leqslant 0.05$), and among ageing population except occupation (Table 3).

Here, to test the contribution of each variable on disability, "-2Log likelihood"(-2LL), an indicator which used to compare nested (reduced) models was introduced in the binary logistic regression. And each time we removed one variable to test the changes of the model by the value of "-2 Log likelihood" expressed by "△(-2LL)", then it was put back into the model again. Also, in the regression model, when the variable was removed, the change of "Nagelkerke R^2" were calculated, which was used to test the changes of goodness of fitness of the regression model, and expressed by "$\triangle R^2$".

Table3 Binary logistic regression of disability among Chinese people and older adults, 2006

Variable	subset	Total population (n=2526145)				Ageing population (n=354859)			
		B	**sig.**	$\lvert\Delta(-2LL)\rvert$	**ΔR^2**	**B**	**sig.**	$\lvert\Delta(-2LL)\rvert$	**ΔR^2**
				938054.7	**26.1**			**355731.5**	14.3
Age				6998.1	0.7			9592	3.7
0-14	60+	1.83							
	15-59	1.20							
60-69	80+					0.87	0.000		
	70-79					0.50	0.000		
Sex		-0.69	0.000	12369.3	1.2	-0.37	0.000	950.4	0.4
Residence		-0.09	0.000	142.2	0	0.02	0.714	217.1	0
Nationality		0.07	0.000	56.7	0	-0.09	0.184	25.9	0
Education				35566.2	3.4			1284.5	0.5
	Never attended school	1.98	0.000			1.37	0.000		
	Primary school	1.27	0.000			1.05	0.000		
	Middle school	0.33	0.000			0.72	0.006		
Marital status				2811.6	0.3			1164.1	0.5
	Unmarried	-0.02	0.094			1.29	0.000		
	Divorced	0.95	0.000			0.84	0.003		
	widowed	0.30	0.000			0.13	0.029		
Employment		1.64	0.000	1194.5	0.1	0.77	0.000	5337.8	2.1
Income		0.000	0.000	3399	0.3	0.000	0.000	699.9	0.3

GDP Per capita (yuan)				129.4	0			58.9	0.0
	⩽10000	-0.14	0.000			18.58	0.999		
	10000-30000	-0.12	0.000			18.83	0.999		
Occupation (type)				1275	0				
	Type I	0.14	0.029						
	Type II	0.06	0.276						
	Type III	0.69	0.148						
	Type IV	0.13	0.001						
	Type V	0.10	0.003						
	Type VI	-0.47	0.000						
Constant		-5.06	0.000			-21.60	0.999		

Notes: (1) 95% confidence interval for OR in the logistic regression model;

(2) R^2: Nagelkerke R^2;

(3) -2LL: -2 Log Likelihood

According to the results of "△(-2LL)" and Nagelkerke R^2 analysis, education, sex, age, marital status, income and employment were the top 6 impact factors on disability for total population (occupation was excluded for $\triangle R^2=0$, and only type IV, V, and VI are statistically significant to disability); while age, employment, education, marital status, sex and income were the top 6 for older adults, and occupation was excluded from the original logistic regression model of older adults, for each type of occupation had a very small sample size(table 3). The contribution of age on disability is much greater in the older adults than that in total population, but the prevalence f disability is definitely accumulated from the beginning of a life. For lack the marital information in total population projection, so, here we didn't choose it as a main parameter.

Finally, base on an assumption of a steady-going macro economic development, a binary logistic regression model with independent variables of age, sex, education, employment and income for disability among total population was chosen to make projection of older adults with disability (table 4). We have transformed some of the independent variables in the final model: (1) provincial proportion of older adults (X_1); (2) Age specific proportion of the employed (X_5); (3) logarithm of the variable "per capita of household income" (X_6). An equation was got as follows:

$$\ln[\frac{p}{(1-p)}] = 0.405 + 0.051X_1 - 0.264X_2 + 0.336X_3 - 2.023X_{4\_4} - 1.677X_{4\_3} - 0.939X_{4\_2} - 0.11X_5 - 0.0824X_6$$

Here, p represents the prevalence rate of disability.

Table 4, Binary logistic regression of disability among Chinese people with selected variables, 2006

(Regression model for forecasting)

Variables	subset	B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Provincial proportion of older adults (X_1)		0.051	0.001	1760.24	1	0.000	1.052	1.050	1.055
Sex(X_2)		-0.264	0.005	2385.19	1	0.000	0.768	0.760	0.776
Residence(X_3)		0.336	0.007	2657.21	1	0.000	1.399	1.381	1.417
Education	college(X_{4_4})	-2.023	0.023	7967.86	1	0.000	0.132	0.127	0.138
	Middle school (X_{4_3})	-1.677	0.008	45874.40	1	0.000	0.187	0.184	0.190
	Primary school (X_{4_2})	-0.939	0.006	21853.02	1	0.000	0.391	0.386	0.396
Age specific proportion of the employed (X_5)		-0.110	0.008	201.28	1	0.000	0.896	0.882	0.910
Lg(INCOME)(X_6)		-0.824	0.008	10874.35	1	0.000	0.439	0.432	0.446
Constant		0.405	0.027	228.19	1	0.000	1.499		

Note: B, the coefficient of logistic model; SE, standard error; Wald., index indicating the significance of the independent variables; d.f., degree of freedom; OR, odds ratio; 95% CI, 95% confidence interval for OR.

Future trends of older adults with disability

Combined with the result of total population projection, both two scenarios showed an increasing changing tendency of older adults with disability. According to the Data Bulletin of the Second National Sample Survey on disability in 2006, total number of older adults with disability was 44.16million[46]. Using the result of total population aged 60 and over projection (middle scenario) combined with the disability prevalence predicted by the regression model, the number of people aged 60 and older with disability under the two scenarios are 44 million and 36 million respectively in 2006, and increases to 129 million and 135million respectively in 2050.

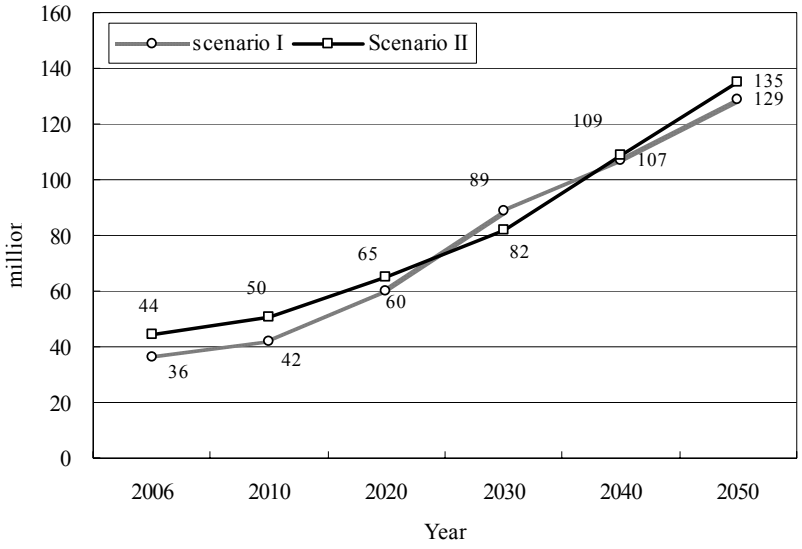

Fig. 3, Population size of older adults with disability under two scenarios (2006-2050)

However, the annually average growth rate for the entire population aged 60+ with disability follows a trend different to that of the total number: the rate increases slightly from 3.46% to 4.78% between 2006 and 2030, and falls to 2.44% in 2050. Annually average growth rates for total population aged 60+ also reach the peak in 2030, which account for 4.83%. From 2030 to 2050, the curve for people with disability falls moderately to 3.27% in 2040, while for the total elderly, it rapidly falls to 2.04% in 2040. (Figure 4)

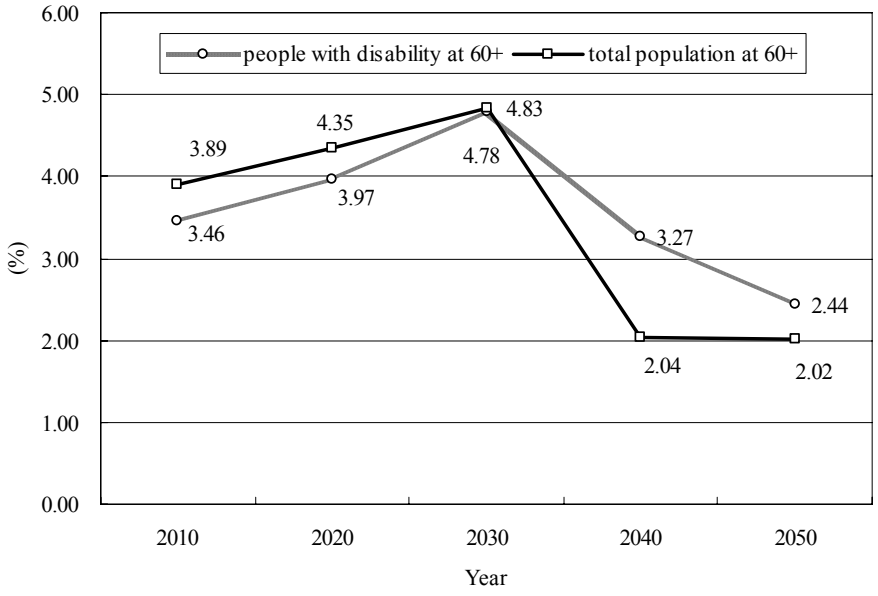

Fig.4 Annually average growth rate of older adults and older adults with disability (2006-2050)

Figure 5 shows the changing of total number of older adults with disability for different provinces in China from 2006 to 2050 compare with their GDP per capita in the base year of 2006. If put aside the possibility of future changing in provincial GDP distribution, all the provinces will have an expanding size on older adults with disability.

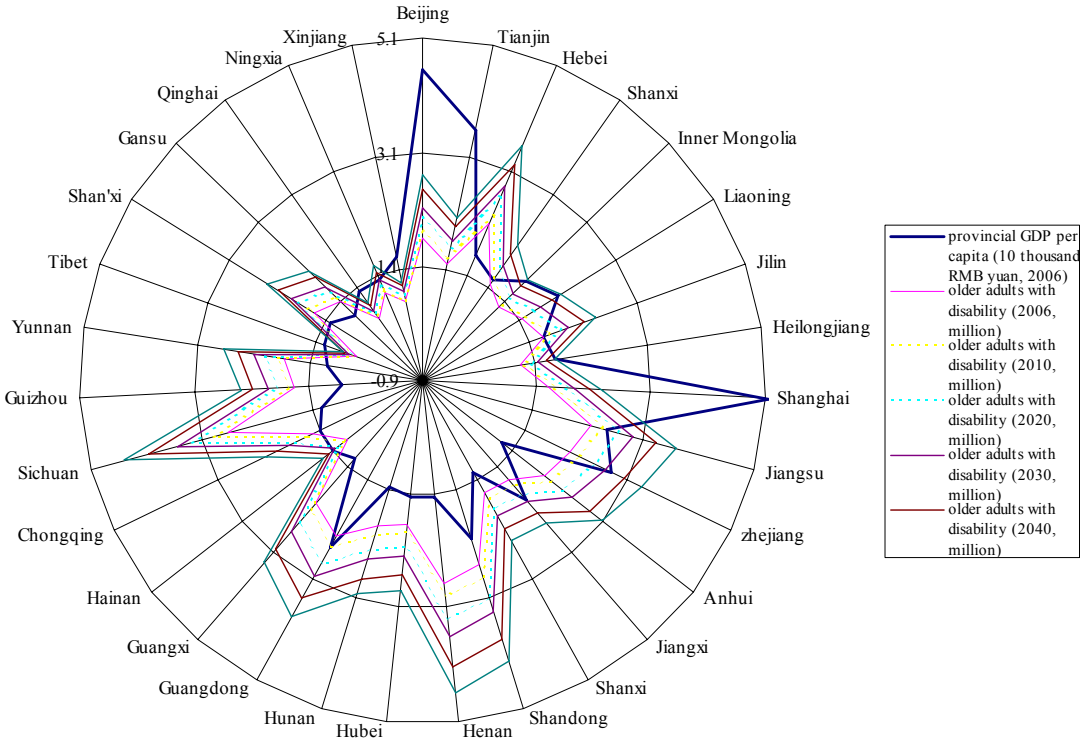

Fig. 5, total number of older adults with disability for different provinces in China from 2006 to 2050 compare with their GDP per capita in the base year of 2006.

Base on the GDP per capita increasing tendency in the future 40 years[47], figure 6 shows the average number of older adults afforded by one GDP per capita (RMB yuan), With the rapid economic development, The average number of older adults afforded by one RMB yuan will decline in the future 40 years for every province s. But those provinces with the highest GDP per capita, such as Beijing, Shanghai, and Guangdong, every one RMB yuan will afford the relatively lower ageing population with disability than those with lowest GDP per capita, such as Yunnan and Guizhou which located in southwest of China.

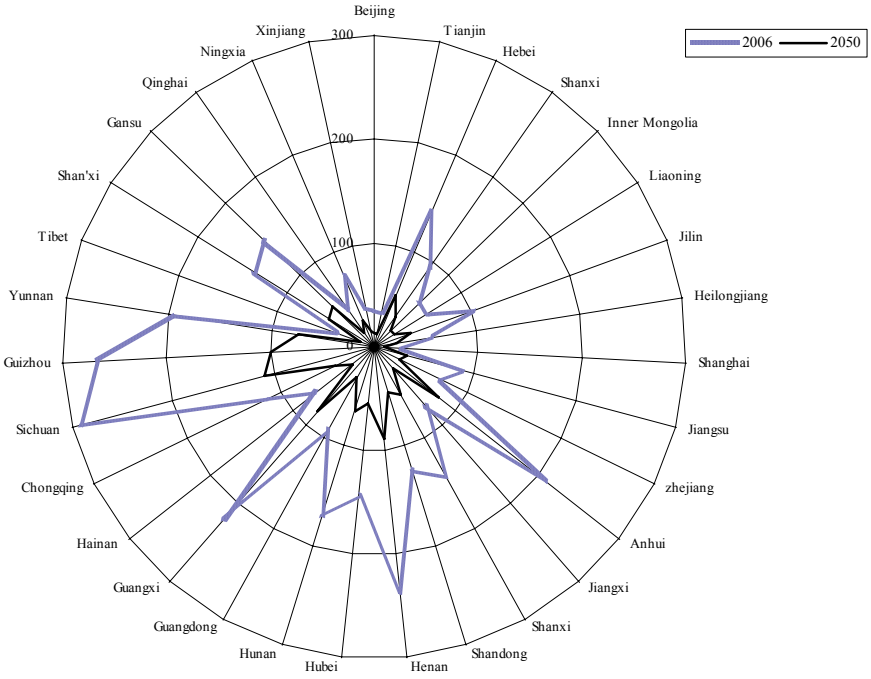

Fig 6 Provincial average number of older adults afforded by one GDP per capita (RMB yuan) (2006, 2050)

Discussion

After completing its demographic transition, Chinese population now is experiencing a rapid aging process. With the prolonged life expectancy of the elderly population, disability becomes most common among them[48]. According to the result of risk factors of disability analysis in our study, the risk of age bring to disability in the elderly population is much higher than that in other age groups; and among the older adults, it woks on the people aged 80+ even higher, which provide an evidence that the prevalence of disability for Chinese older adults will go up with the increasing of ageing population.

In China, the risk of disability for rural and urban residence has a significant difference, which mainly caused by an unbalanced social and economic development between the two areas[6, 49]. In other words, China's future economic development with a narrowing or widening the gap will bring a difference impact on disability[50].

The results of this study show that population with higher education level has lower probability of occurrence of disabilities, which is similar with some of the foreign studies[5152],[53].

And our study also showed that, from a macro perspective, an overall impact of regional economic environment on the occurrence of disability can be expressed as: the higher level of regional economic development, the lower the probability of occurrence of disability. And from the microscopic point of view, the higher level of per capita household income, the lower probability of occurrence. The findings in our

research do not mean that the family economic environment will directly result in disabilities, but explain a possibility that a good family economic conditions is closely related to some of the risk factors such as education of family members, awareness of health risk prevention etc., which directly result in disability[54].

The risk of disability brings by occupation plays an important role on working-age population, and has much less impact on older adults who mostly retired. But the occurrence of disability caused by occupation risk will accumulated to the old age[55],[56]. So, to avoid the occupational risk should be paid more attention.

The future total number and growth rate of older adults with disabilities in China are very striking. Under scenario II, about 1.5 million of older adults increase annually from 2006 to 2040, and more than 2.5 million increase annually from 2040 to 2050. Total number in 2050 is 3.05 times of 2006. Compare with other age groups, the degree of disability in older adults is often more severe, and possibility of full recovery less than the others[57],[58]. The elderly are asking for more services and security to live a dignified life. China didn't establish a universal health services system yet, so a considerable proportion of the older adults can not enjoy a comprehensive set of benefits that include physician and hospital services, dental care, prescription drugs, and long-term care, especially living in western China and remote rural area[59]. The implications of future changing tendency of older bring a huge challenge of the health services system. One way to mitigate these negative consequences is to improve health and functioning and reduce disability.

This study selected the data from a cross-sectional sample survey on disability in 2006 as the basis of analysis to quantify the relationship between demo-socio-economic variables and prevalence of disability. It should be noted that, the impact of different types of factors on disability both include congenital reasons and acquired reasons, the difference of these reasons is not made an in-depth discussion. In addition, the prevalence status of disability on the standard survey point are reflected the results cumulative effect of the risk factors from the past years, even past decades, and many of these factors differ significantly across countries, and across cohorts within countries. All the background information related to disability in the survey can only reflect the status of the survey point, but not the exact causes of disability, therefore, the interpretation of this study on the relationship between the variables would have some errors. Actually, the definition and standard of disability in the Second Sample Survey is from a clinical point of view, and much more strictly compared with those used by other developed countries. So, some people have not been defined as the disabled whose potential demand has been underestimated.

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