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Public Health

journal homepage: www.elsevier.com/puhe

Original Research

Heterogeneous health classes for older adults and their regional disparities in China: based on multidimensional health

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ARTICLE INFO

Article history:

Received 10 April 2019

Received in revised form

13 August 2019

Accepted 24 August 2019

Available online 9 October 2019

Keywords:

Multidimensional health

Heterogeneity

Regional disparities

Aging

China

ABSTRACT

Objectives: China is currently facing an unprecedented complex health demand from a rapidly aging population. Based on multidimensional health, this study aimed to identify heterogeneous latent health classes for older Chinese people, and assess regional disparities and associated sociodemographic factors.

Study design: Chinese Longitudinal Healthy Longevity Survey in 2014 was adopted.

Methods: For 2886 participants aged 65 years and more without missing health indicators in physical, psychological, and social dimensions, latent class analysis was used to identify heterogeneous health. For 2128 participants with complete information, logistic regressions were used to examine how regional divisions and sociodemographic factors impact each identified class.

Results: Four classes were identified and labeled as ‘Lacking Socialization’ (17.4%), ‘High Comorbidity’ (13.7%), ‘Functional Impairment’ (7.1%), and ‘Relative Health’ (61.8%). When the Relative Health class was the reference, the likelihoods of the High Comorbidity and Functional Impairment classes were higher for older adults in eastern and central regions than in western regions. Those in eastern regions also tended to be in the Lacking Socialization class than in western regions. The effects of regional divisions on the different classes were significantly impacted by socio-demographic characteristics.

Conclusions: Four health classes identified by multidimensional health have enhanced our understanding of heterogeneity among older Chinese people. By examining regional disparities in China, our study provided evidence for health policies addressing the issue of aging with respect to regional disparities.

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Introduction

With decreased fertility and mortality, China is now facing great public health challenges of a rapidly aging population. The share of older Chinese people aged 65 years and more is expected to increase from 14% in 2015 to 26% in 2050, unprecedentedly becoming the largest older population around the world.¹ Older adults with higher risks of chronic diseases and disabilities are typically associated with greater health and social care costs. Some specific combinations of chronic diseases have a disproportionate effect on the utilization of health care different from a simple sum of each of the disease burdens.² To address population aging and relevantly disproportionate burdens of health and social care, it is urgent to comprehensively and accurately assess the health status of older Chinese people.

When elucidating observable differences in health, previous studies focusing on older adults considered health indicators including chronic diseases or symptoms, activities of daily living (ADLs), mental or memory problems, and social engagement.^{3,4} The definition of health by the World Health Organization refers to a state of complete well-being on physical, psychological, and social dimensions.⁵ Each health indicator can be regarded as a dimension of health. Multidimensional health indicators interact to jointly influence the holistic health state, leading to highly heterogeneous health in older adults.^{6,7} The heterogeneity of older health could be introduced by the associations among health indicators of multiple dimensions, and then represented as possible health subgroups with similar characteristics in health indicators. To assess the heterogeneity of older health, it is important to shift the traditional view of health on each distinct health indicator to multidimensional health by person-centered approaches.^{7,8} Nevertheless, the heterogeneity of multidimensional health for older Chinese people has not been well documented. In addition, previous studies on the heterogeneity of health mainly focused on the physical and psychological health status of older adults, but did not take the social health status into account.^{3,4} Hence, there is a need to integrate all three health dimensions for a more comprehensive measurement of heterogeneous health.

Along with the growing heterogeneity of health in late adulthood, there is also an increasing concern of socio-demographic health disparities, especially regional health disparities, in older adults.⁹ Since the economic reforms in the late 1970s, the Chinese government has clearly emphasized the development of coastal/eastern areas. Because of the polarized development in economic growth and urbanization, there exists substantial geographic differences in health and social care systems. These regional disparities lead to disparities in older health, and they exist not only between urban and rural areas,¹⁰ but also among western, central, and eastern regions in China.¹¹ Studies that examined regional disparities in older people mainly considered the relationships with specific or limited health indicators, rather than with multiple dimensions of health. Furthermore, the discussion about how sociodemographic factors impact the regional disparities of older health remains limited.

Based on multidimensional health, this study aimed to integrate physical, psychological, and social health indicators to identify heterogeneous latent health classes for older Chinese people. Furthermore, this study assessed regional disparities of latent health classes, and examined the impact of sociodemographic factors for different regions.

Methods

Data sources and study population

Data came from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) in 2014. The CLHLS was a collaborative project between Duke University and Peking University. It provides information on the health, socio-economic characteristics, and lifestyle of older adults aged 65 years and more, which were drawn from 800 randomly selected counties and cities of the 22 provinces of China. The CLHLS data were collected by face-to-face interviews and self-enumerated questionnaires. Details on the survey design and data quality assessment have been reported in previous studies.¹² Among 7192 participants, 2886 participants aged 65 years and more without missing health indicators were included in the analyses of latent health classes. 2128 of them with complete variables, containing not only health indicators, but also regional and sociodemographic information, were included in the analyses of regional disparities and impact factors. In terms of the characteristics of sociodemographics and health indicators, except for the occupation before 60 years of age, 2128 participants with complete information had no differences with 2886 participants without complete information (see [Table S1 in the supplementary material](#)).

Variable definitions

Health indicators

This study selected 10 health indicators to determine latent health classes. These health indicators described the following three dimensions of health: physical, psychological, and social health status.

Indicators of physical health status included chronic conditions and functional disabilities. Chronic conditions consisted of the following five self-reported diseases (yes/no): cardiovascular diseases, endocrine diseases, respiratory diseases, musculoskeletal diseases, and sensorial diseases. Functional disabilities were measured based on six ADLs and eight instrumental activities of daily living (IADLs). Those requiring assistance in any one of ADLs or IADLs were defined as 'with difficulties.' The measure of ADLs was defined as 'no difficulty' or 'with difficulties.' The measure of IADLs was defined as 0–2 activities, 3–4 activities, or ≥ 5 activities 'with difficulties.'

Indicators of psychological health status included cognitive problems and depression. Cognitive problems (yes/no) were measured based on the Chinese version of the Mini-Mental State Examination (MMSE) scores (0–30) adjusted by three educational levels. Those having cognitive problems were defined as follows: ≤ 19 MMSE scores for those with no formal education, ≤ 22 MMSE scores for those with ≤ 6 years of

education, and ≤ 26 MMSE scores for those with ≥ 7 years of education.¹³ Depression (yes/no) was composed of two questions about feeling depressed and losing interest in things. Those having depressive symptoms were defined as the response with 'yes' for either of the two questions.¹⁴

Social health status was derived from both structural and functional measures,¹⁵ and consisted of five elements with scores ranging from 0 to 5. The structural measures were constructed from three elements: marital status (1 = in marriage, including 'currently married and living with spouse' and 'married but not living with spouse'; 0 = not in marriage, including 'divorced,' 'widowed,' and 'never married'), living arrangement (1 = with household member or in a nursing home, 0 = alone), and attending social activities or playing cards and/or mah-jong (1 = at least once a month or more, 0 = otherwise). The functional measures were composed of two elements: the availability of help when required (1 = somebody, 0 = nobody); the availability of a confidant (1 = somebody, 0 = nobody).¹⁶ Those with 0–3 scores indicated a lack of socialization.

Regional divisions

Based on the 2014 version of the China Health and Family Planning Statistical Yearbook,¹⁷ this study divided the 22 sampled provinces in CLHLS into three regions dictated as: western, central, and eastern regions. The western regions were the least developed regions in China, composed of the following four provinces: Sichuan, Chongqing, Shaanxi, and Guangxi. The central regions were next to the western regions, composed of the following eight provinces: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. The eastern regions, alongside the coastal area, were the most developed regions composed of the following 10 provinces: Liaoning, Beijing, Tianjin, Hebei, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, and Guangdong.

Sociodemographic covariates

Sociodemographic characteristics in this study included age (65–79 years, ≥ 80 years), gender, marital status (not in marriage, in marriage), living arrangement (alone, with others), education (illiterate, literate or primary school, junior high and above), residence area (rural, urban), main occupation before age 60 years (agriculture, professional/management occupation, others), annual household income per capita (divided into quartiles: lower than 6000 yuan, 6000–20,000 yuan, 20,000–40,000 yuan, higher than 40,000 yuan), and three main social health insurance schemes: Urban Employee Basic Medical Insurance, Urban Resident Basic Medical Insurance (UR-BMI), and New Rural Cooperative Medical Scheme (NRCMS).

Statistical analyses

This study compared the characteristics of sociodemographic and health indicators for older adults in different regions by chi-squared test. As a person-centered approach suitable to handle the heterogeneity, latent class analysis (LCA) was adopted to identify heterogeneous latent health classes based on health indicators. Conditional health indicator probabilities and latent health class probabilities were estimated.

Conditional health indicator probability described the relationship between latent health classes and observed indicator variables, corresponding to the indicator-response probability in the LCA model.¹⁸ Latent health class probabilities specify the individual's relative probability of belonging to each health class. LCA models with 2–5 classes were conducted. The performance of the models was compared by Bayesian Information Criterion (BIC), and adjusted BIC (aBIC). Logistic regressions were used to examine regional disparities of latent health classes and the impact of sociodemographic factors. All statistical analyses were performed using R version 3.5.1. A *P*-value < 0.05 was regarded to be statistically significant.

Results

Latent health classes for older adults

Significant differences of sociodemographic and health indicators among older adults in different regions were found, including residence area, occupation before 60 years of age, household income, UR-BMI, cardiovascular diseases, endocrine diseases, sensorial diseases, ADLs difficulties, and IADLs difficulties (Table 1).

All 10 health indicators were selected for the LCA models. Among models with 2–5 classes, the four-class model obtained the smallest aBIC (24,470.8) and relatively smaller BIC (24,619.8). Furthermore, one class of the four-class LCA model was characterized by a relatively high probability of lack of socialization, which was meaningful for theoretical distinction on social health status as one dimension of health (Table 2). Therefore, this study adopted the four-class LCA model.

The labels for latent health classes were defined by comparison among conditional health indicator probabilities (λ ; Table 2). The first class ($n = 501$, 17.4%) was prone to have higher probabilities for lack of socialization ($\lambda = 0.712$) and IADLs difficulties with five or more activities ($\lambda = 0.398$). Thus, this study labeled this class of older adults as 'Lacking Socialization' (LS). The second class ($n = 396$, 13.7%) tended to have higher probabilities for most chronic conditions and the highest probability of depression ($\lambda = 0.324$), and was labeled as 'High Comorbidity' (HC). Older adults in the third class ($n = 205$, 7.1%) had the highest probabilities of ADLs difficulties ($\lambda = 0.893$), IADLs difficulties with five or more activities ($\lambda = 1.000$), and depression ($\lambda = 0.753$). This class was labeled as 'Functional Impairment' (FI). The last class ($n = 1784$, 61.8%), labeled as 'Relative Health' (RH), was identified by lower probabilities of most chronic conditions, the lowest probabilities of ADLs difficulties ($\lambda = 0.009$), IADLs difficulties with 0–2 activities ($\lambda = 1.000$), cognitive impairment ($\lambda = 0.014$), and lack of socialization ($\lambda = 0.350$).

Regional disparities of latent health classes

After controlling for other sociodemographic covariates, the results of the multinomial logistic regressions on latent health classes indicated significant effects of regional divisions, when taking the RH class as the reference (Table 3). The likelihood of the HC and FI classes was higher for older adults in central regions than in western regions (odds ratio [OR]:

Table 1 – Characteristics of sociodemographics and health indicators for older adults in different regions.

Variables	Total (n = 2128)		Western (n = 588)		Central (n = 593)		Eastern (n = 947)		P-value
	n	%	n	%	n	%	n	%	
Age, y									0.078
65–79	993	46.66	265	45.07	300	50.59	428	45.2	
≥80	1135	53.34	323	54.93	293	49.41	519	54.8	
Gender									0.699
Female	1005	47.23	278	47.28	288	48.57	439	46.36	
Male	1123	52.77	310	52.72	305	51.43	508	53.64	
Current marital status									0.128
Not in marriage	1035	48.64	308	52.38	279	47.05	448	47.31	
In marriage	1093	51.36	280	47.62	314	52.95	499	52.69	
Living arrangement									0.066
Alone	421	19.78	98	16.67	127	21.42	196	20.7	
With others	1707	80.22	490	83.33	466	78.58	751	79.3	
Education									0.216
Illiterate	1010	47.46	268	45.58	298	50.25	444	46.88	
Literate or primary school	793	37.27	233	39.63	198	33.39	362	38.23	
Junior high and above	325	15.27	87	14.8	97	16.36	141	14.89	
Residence area									<0.001
Rural area	1062	49.91	212	36.05	359	60.54	491	51.85	
Urban area	1066	50.09	376	63.95	234	39.46	456	48.15	
Main occupation before 60 years of age									<0.001
Agriculture	1518	71.33	469	79.76	410	69.14	639	67.48	
Professional/managerial	180	8.46	41	6.97	59	9.95	80	8.45	
Others	430	20.21	78	13.27	124	20.91	228	24.08	
Household income, yuan									<0.001
<6000	495	23.26	99	16.84	187	31.53	209	22.07	
6000–20,000	488	22.93	130	22.11	122	20.57	236	24.92	
20,000–40,000	537	25.23	196	33.33	144	24.28	197	20.8	
>40,000	608	28.57	163	27.72	140	23.61	305	32.21	
Health insurance									
UE-BMI	267	12.55	68	11.56	82	13.83	117	12.35	0.488
UR-BMI	172	8.08	62	10.54	30	5.06	80	8.45	0.002
NRCMS	1499	70.44	416	70.75	417	70.32	666	70.33	0.982
Physical health status									
Cardiovascular diseases	926	43.52	207	35.2	281	47.39	438	46.25	<0.001
Endocrine diseases	130	6.11	23	3.91	39	6.58	68	7.18	0.029
Respiratory diseases	250	11.75	66	11.22	79	13.32	105	11.09	0.373
Musculoskeletal diseases	243	11.42	72	12.24	77	12.98	94	9.93	0.141
Sensorial diseases	254	11.94	45	7.65	84	14.17	125	13.2	0.001
ADLs difficulties	225	10.57	34	5.78	79	13.32	112	11.83	<0.001
IADLs difficulties									<0.001
0–2	1502	70.58	451	76.7	418	70.49	633	66.84	
3–4	264	12.41	67	11.39	60	10.12	137	14.47	
≥5	362	17.01	70	11.9	115	19.39	177	18.69	
Psychological health status									
Cognitive impairment	102	4.79	23	3.91	34	5.73	45	4.75	0.341
Depression	290	13.63	87	14.8	86	14.5	117	12.35	0.306
Social health status									0.662
Lacking socialization	972	45.68	279	47.45	263	44.35	430	45.41	

2128 older adults with complete information.

UE-BMI, Urban Employee Basic Medical Insurance; UR-BMI, Urban Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme; ADLs, activities of daily living; IADLs, instrumental activities of daily living.

1.740 and 2.834). Besides the same as central regions (HC OR: 1.941; FI OR: 3.081), those in eastern regions also tended to be in the LS class (OR: 1.696) than western regions. Older adults in the LS and FI classes were prone to be older, not in marriage, living with others, and have lower household income. The LS and HC classes were less likely to be male (OR: 0.707 and 0.514,

respectively). The LS class tended to live in rural areas (OR: 0.696), whereas the HC class was prone to be in urban areas (OR: 1.412). Older adults in the HC class were less likely to enroll in NRCMS (OR: 0.458), whereas those in the FI class were less likely to enroll in UR-BMI or NRCMS (OR: 0.385 and 0.268, respectively).

Table 2 – Conditional probabilities of health indicators in each health latent class of older adults.

Dimensions	Sample proportion (n = 2886)	LS	HC	FI	RH
		(n = 501)	(n = 396)	(n = 205)	(n = 1784)
Physical health status					
Cardiovascular diseases	0.437	0.320	0.776	0.507	0.348
Endocrine diseases	0.058	0.007	0.197	0.068	0.025
Respiratory diseases	0.113	0.097	0.210	0.191	0.074
Musculoskeletal diseases	0.113	0.054	0.307	0.082	0.067
Sensorial diseases	0.122	0.079	0.302	0.166	0.066
ADLs difficulties	0.108	0.126	0.102	0.893	0.009
IADLs difficulties					
0–2	0.708	0.162	0.663	0.000	1.000
3–4	0.126	0.440	0.211	0.000	0.000
≥5	0.166	0.398	0.126	1.000	0.000
Psychological health status					
Cognitive impairment	0.050	0.087	0.045	0.262	0.014
Depression	0.131	0.080	0.324	0.239	0.066
Social health status					
Lacking socialization	0.455	0.712	0.399	0.753	0.350

2886 older adults without missing health indicators.

LS, Lacking Socialization; HC, High Comorbidity; FI, Functional Impairment; RH, Relative Health; ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Sociodemographic characteristics of latent health classes among different regions

Latent health classes had different sociodemographic characteristics among different regions (Table 4). When the RH class was the reference, the effects of age and living arrangement on the FI class in eastern regions (OR: 11.212 and 7.336, respectively) were significantly larger than those of other classes or other regions. The HC class in central regions was prone to be younger (OR: 0.450), whereas those in eastern regions tended to be older (OR: 1.854). Besides the LS and RI classes in all regions, older adults of the HC class in western regions were less likely to be in marriage (OR: 0.475). With regard to education, which was not significant for any analyses across the whole sample, the LS class in eastern regions was less likely to be literate or have primary education than to be illiterate (OR: 0.575). The significant effects of residence area on the LS and HC classes were only found in eastern regions (OR: 0.653 and 1.987, respectively). Older adults of the FI class in western regions were less likely to have more than 40,000 yuan of household income (OR: 0.129), and its likelihood was even less than that of the same class in eastern regions (OR: 0.363). In terms of health insurance, the LS class in central regions was less likely to enroll in UR-BMI (OR: 0.078).

Discussion

Through the person-centered approach of LCA, this study systematically integrated multidimensional health indicators to identify four heterogeneous latent health classes for older adults in China. Except for the other three classes that had similar characteristics with previous latent classifications,¹⁹ the LS class was characterized by the health indicator from the social dimension. It indicated that introducing a social

health dimension was important for the assessment of heterogeneous health in the older Chinese population.

Meanwhile, older adults in the LS class were accompanied by the characteristic of functional limitation. Previous evidence suggested that a complex reciprocal relationship may exist, in which social participation helps to prevent disability and functional ability enables continued social engagement.^{20,21} Hence, older adults in the LS class deserved attention to social health as well as physical health.

Of greater concern is significant regional disparities existing among health classes for older Chinese people. Our findings showed that older adults in eastern and central regions had worse health status than those in western regions, which was not in accordance with previous studies.^{11,22} The unbalanced economic development among regions has led to a widened gap in access to health care resources, and vulnerable older adults cannot enjoy the same level of health care.²³ Meanwhile, older Chinese people in western regions may face under-diagnosis, less report of chronic conditions,²⁴ and were prone not to be in the HC class. Similarly, this phenomenon was also found in rural older adults within eastern regions.

Regional disparities of health classes in this study may be related to the sociodemographic characteristics of different regions. With increasing age, older adults become frail and vulnerable, and tend to be in the LS and FI classes. As for central regions, it is remarkable that older adults in the HC class tend to be younger, which may be related to the unfolding crisis of rising rates in obesity and chronic diseases among young-old adults.²⁵ The focus of health policies has lagged behind this substantive change in age profile of chronic diseases,²⁵ and there is an urgent need for public health initiatives to focus on chronic disease management for young-old people in central regions.

In our study, we found that males were less likely to be in the HC class, especially among central and eastern regions,

consistent with previous studies.²⁶ Furthermore, older adults in the LS and FI classes were less likely to have marital status. The effect of marriage was significantly magnified in western regions. Previous research found that marriage yields some benefits: healthier behaviors, increased income, and emotional/instrumental support,²⁷ which may benefit health outcomes of older adults. At the same time, adult children usually migrated from inland/western province to coastal/eastern province for work in China. With the weakened support of children in society, empty-nested older adults have been seen a shift in assisting support from children to their spouses.

Table 3 – Results of logistic regressions on the health latent classes of older adults.

Variables	LS vs RH	HC vs RH	FI vs RH
Region divisions			
Western	Ref	Ref	Ref
Central	1.237	1.740**	2.834***
Eastern	1.696**	1.941***	3.081***
Age, y			
65–79	Ref	Ref	Ref
≥80	5.418***	1.150	7.485***
Gender			
Female	Ref	Ref	Ref
Male	0.707*	0.514***	0.944
Marital status			
Not in marriage	Ref	Ref	Ref
In marriage	0.344***	0.719	0.183***
Living arrangement			
Alone	Ref	Ref	Ref
With others	1.786**	1.371	4.942***
Education			
Illiterate	Ref	Ref	Ref
Literate or primary school	0.744	1.079	0.623
Junior high and above	0.555	1.134	0.934
Residence area			
Rural	Ref	Ref	Ref
Urban	0.696*	1.412*	0.795
Main occupation before 60 years of age			
Agriculture	Ref	Ref	Ref
Professional/managerial	0.660	1.161	1.210
Others	0.976	0.995	0.952
Household income, yuan			
6000	Ref	Ref	Ref
6000–20,000	0.610*	1.139	0.646
20,000–40,000	0.770	1.311	0.702
>40,000	0.619*	0.817	0.413**
Health insurance			
UE-BMI	0.935	0.823	0.630
UR-BMI	0.515	0.937	0.385*
NRCMS	0.620	0.458***	0.268***

2128 older adults with complete information.

LS, Lacking Socialization; HC, High Comorbidity; FI, Functional Impairment; RH, Relative Health; Ref, reference; UE-BMI, Urban Employee Basic Medical Insurance; UR-BMI, Urban Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme.

Values were odds ratios; the RH class was set as reference in the regressions.

*P < 0.05; **P < 0.01; ***P < 0.001.

As previous research indicated, the advantage of living alone may be associated with the ability of dealing with daily life activities by oneself and the presence of assistance from a social network.^{19,28} In our study, we found that older adults in the FI class were prone to live with others, particularly in eastern regions. In better-developed eastern regions, emigration of younger people was not notable, and housing shortages encouraged older adults and their children to share the same house,²⁹ which could provide additional intergenerational support to older adults. Also in these areas, nursing home care was more available for frail older adults in China.³⁰ Thus, frail older adults in eastern regions were able to get assistance and live longer by living with others.

To tackle the poor access to health care and the burden of medical expenditure, China has established a series of social health insurance schemes. Existing evidence suggested that social health insurance played a positive effect on the equity of health care coverage and can benefit the health of older adults.³¹ We found that older adults enrolled in NRCMS were less likely to be classified to the HC and FI classes, especially for frail older adults in western and central regions. NRCMS has improved the accessibility of health care services for rural residents,³² leading to the improvement of older health. To provide better financial protection for the vulnerable Chinese seeking essential health care, China plans to fully establish a unified national medical insurance service, consolidating NRCMS and UR-BMI, for both urban and rural citizens across the country by the end of 2019.³³ This movement has promoted building an equitable and efficient health coverage system for more people.

Our study still has some limitations that should be noted. First, only participants with complete information were involved in the analyses of regional disparities. Although there were no significant differences between those with and without complete information for most characteristics, results could still be potentially biased. Representative samples with complete information should be considered for further study. Second, the measures of diseases were defined by self-reporting, rather than by doctor identification with abundant missing data. More objective and accurate health indicators may be used to improve the assessment of latent health classes. Third, this study was based on cross-sectional analyses, but it would be fruitful to evaluate the validity of latent health classes with longitudinal data.

In summary, four latent health classes with heterogeneity were identified by multidimensional health for older adults in China. Integrating physical, psychological, and social health dimensions can provide a more comprehensive assessment on the heterogeneity of older health. The latent health classes showed abundant regional disparities and had different socio-demographic characteristics across different regions, which were critically important for identifying high-risk groups of older people. This study enhanced our understanding of the regional disparities related to the multidimensional health of older adults, and provided evidence for policy development and clinical decisions to address the complex health issue of the nationwide elderly population in China.

Table 4 – Results of logistic regressions on the health latent classes of older adults in different regions.

Variables	Western (n = 588)			Central (n = 593)			Eastern (n = 947)		
	LS vs RH	HC vs RH	FI vs RH	LS vs RH	HC vs RH	FI vs RH	LS vs RH	HC vs RH	FI vs RH
Age, y									
65–79	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
≥80	3.859***	1.301	7.503*	6.856***	0.450*	4.690***	5.736***	1.854**	11.212***
Gender									
Female	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Male	0.902	0.610	1.857	0.519*	0.420**	0.743	0.694	0.481**	0.880
Marital status									
Not in marriage	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
In marriage	0.433**	0.475*	0.086***	0.414**	0.613	0.226***	0.256***	1.035	0.156***
Living arrangement									
Alone	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
With others	1.499	1.665	4.261*	1.839	0.898	3.549**	2.051*	1.338	7.336***
Education									
Illiterate	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Literate or primary school	0.841	1.174	0.620	1.148	1.509	0.577	0.575*	0.830	0.654
Junior high school and above	0.668	1.635	0.974	0.180	1.037	1.256	0.571	0.966	0.717
Residence area									
Rural	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Urban	0.695	1.137	1.059	0.937	1.006	0.707	0.653*	1.987**	0.695
Main occupation before 60 years of age									
Agriculture	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Professional/managerial	0.561	2.439	4.744	0.333	0.878	0.236	0.998	1.310	3.128
Others	0.544	1.376	0.916	0.898	1.030	1.061	1.197	0.808	0.953
Household income, yuan									
<6000	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
6000–20,000	0.782	1.852	0.609	0.576	1.107	0.493	0.586	0.914	0.641
20,000–40,000	1.173	1.715	0.487	0.582	1.001	0.806	0.726	1.533	0.727
>40,000	1.059	0.572	0.129*	0.493	0.772	0.685	0.509*	1.062	0.363*
Health insurance									
UE-BMI	2.108	0.760	0.336	0.610	1.612	0.568	0.679	0.513	0.740
UR-BMI	0.968	1.058	0.101	0.078*	2.068	0.337	0.525	0.677	0.692
NRCMS	0.756	0.388	0.103***	0.423	0.544	0.196**	0.647	0.435*	0.437

2128 older adults with complete information.

LS, Lacking Socialization; HC, High Comorbidity; FI, Functional Impairment; RH, Relative Health; Ref, reference; UE-BMI, Urban Employee Basic Medical Insurance; UR-BMI, Urban Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme.

Values were odds ratios; the RH class was set as reference in the regressions.

*P < 0.05; **P < 0.01; ***P < 0.001.

Author statements

Acknowledgements

The authors would like to acknowledge Tian-Shyug Lee and Jian Xiao for their valuable contributions to the project.

Ethical approval

Not required. Data came from the public database of Chinese Longitudinal Healthy Longevity Survey (CLHLS). The original CLHLS was approved by the Ethical Review Committee of Peking University, and all participants signed informed consent at the time of participation.

Funding

This work was supported by the Youth Project of National Social Science Fund of China, China (Grant No. 19CRK008). The funders had no role in study design; in the collection, analysis

and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Conflict of interest

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2019.08.023>.