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Gender differences in cognitive impairment among the old and the oldest-old in China

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Aim: To examine gender differences in the prevalence of cognitive impairment across two age cohorts in China: the old (aged 65–79 years) and the oldest-old (aged 80–116 years).

Methods: The Chinese Longitudinal Healthy Longevity Survey with waves from 2008 to 2011 was used (N = 13 586). Regression analysis was used to model the gender effects on baseline cognitive function and onset of cognitive impairment. Independent variables included demographics, socioeconomic status (SES), social network, leisure activities and functional disabilities.

Results: Among the oldest-old, women (32.9%) were twice as likely as men (15.7%) to have cognitive impairment. For the old, women (2.2%) were only slightly more likely than men (1.9%). Regression models showed the oldest-old women having a significantly higher risk of cognitive impairment than men ($P < 0.001$), even after adjusting for independent variables. No significant gender differences were found among the old cohort. SES, social network and leisure activities appeared to affect gender differences, especially among the oldest-old. Of the independent variables examined, the gender effects were reduced the most when incorporating SES for both age cohorts.

Conclusions: For the oldest-old, gender differences in cognitive impairment could be due to differences in SES between men and women. The old cohort showed no statistically significant gender difference at this time; however, we should follow this old cohort for their future potential gender differences in the prevalence of cognitive impairment. **Geriatr Gerontol Int 2019; 19: 586–592**.

Keywords: China, cognitive impairment, gender differences, the old and oldest-old.

Introduction

China, the most populous country in the world with 1.4 billion inhabitants, accounted for nearly 20% of the world's oldest-old people (13 million people) in 2015.[1,2] This number is predicted to quadruple to 100 million between 2015 and 2050.[2] This increase creates concerns, as the older population tends to have more chronic conditions that require long-term care and consume medical expenses.[3] A growth of longevity naturally increases the number of people with cognitive impairment.[4] Research has identified that the oldest-old women in China are at higher risk of cognitive impairment compared with their male counterparts,[1,5,6] and this gender risk might be due to women's socioeconomic status (SES), social network, participation in leisure activities[5] and early life experience.[6]

China was originated in a feudal, patriarchal society that traditionally privileged men over women in economic, political, social and family situations.[1,5,7] Women did not have formal education and income earning rights until the establishment of People's Republic of China in 1949.[7] Even after 1949, China's long historical policy on sexes continued to result in women remaining subordinate in Chinese society. Based on the birth years, the current oldest-old (1895–1931) and the majority of the old cohort (1932–1946) lived through major historical turmoil in China. Reflecting these historical backgrounds, it is plausible that the oldest-old women might have been in disadvantaged environments throughout their lives. However, it remains unknown if this pattern is unique to the oldest-old cohort. The purpose of the present study was to examine gender differences in the prevalence of cognitive impairment in the old (aged 65–79 years) and oldest-old (ages ≥80 years) cohorts in China. Specifically, the present study aimed to: (i) describe the characteristics of the two age cohorts; (ii) examine the prevalence rates of cognitive impairment; and (iii) identify variables that could possibly reduce gender differences in cognitive impairment.

Methods

The present study used data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The CLHLS includes older adults aged ≥65 years in 22 provinces of China.[6,8] Data were collected based on questionnaires and interviews carried out in 1998, 2000, 2002, 2005, 2008, 2011 and 2014. The CLHLS is the largest longitudinal survey that includes the oldest-old population in a developing county.[6] Given our interests in investigating gender differences in baseline cognitive function and onset of cognitive impairment, the present study included individuals who had data in year 2008 as baseline (n = 16 540) and year 2011 as follow up (n = 9765) for data analysis (the latest datasets we could obtain when this study was carried out). This research was reviewed and given exempt status by the internal review board of the authors' universities.

Dependent variables

The dependent variable, cognitive function, was assessed by the Chinese version of the Mini-Mental State Examination (MMSE).[9] The Chinese MMSE has been tested and modified to fit to the cultural, socioeconomic and literacy levels of older populations in China. The total score ranges from 0 to 30, with higher scores representing better cognitive function. The cognitive function was classified into four categories: (i) no cognitive impairment (24–30);

(ii) mild cognitive impairment (18–23); (iii) moderate cognitive impairment (10–17); and (iv) severe cognitive impairment (0–9). This approach of classification has been widely used and is considered to be clinically meaningful.[5,10] The reliability of the Chinese MMSE was Cronbach's $\alpha = 0.94$.[5]

Baseline cognitive function was categorized as binary to indicate the presence (scores <18) or absence (scores ≥18) of participants' cognitive impairment. For the follow-up cognitive function, the onset of cognitive impairment was determined by the MMSE scores in year 2008 and 2011. We consider the onset of cognitive impairment if participants' MMSE scores were within the normal range (≥18) in year 2008, but scored <18 in year 2011. Participants with a score of ≥18 were treated as within normal cognitive function. Additionally, participants who were lost for follow up or died between 2008 and 2011 were included in the follow-up outcomes (normal cognitive function = 0; lost for follow-up = 1; death = 2; onset of cognitive impairment = 3).

Independent variables

Demographic background

Age, gender and area of residence (urban or rural) were asked during the face-to-face interviews. Participants were grouped into the old and the oldest-old based on the self-reported age. As the focus of the study was gender differences in cognitive impairment, gender was used as the main predictor.

Socioeconomic status

Socioeconomic factors included participants' education and occupation. Participants were asked how many years of formal education they received (no formal education = 0; any years of formal education = 1). Occupation was based on the type of job that participants had before the age of 60 years. This variable was then classified into two categories: agriculture/housework (e.g. farmer, homemaker) = 0 and non-agriculture (e.g. administrator, doctor) = 1, based on whether the occupation involves physical laboring activities.

Social network

Social network factors were captured by the number of participants' social connections. In addition to marital status (married/partnered = 0; single = 1), the number of siblings or children who visited them frequently was recorded.

Leisure activities

These variables were obtained by asking participants if they currently carried out the following activities: (i) exercise; (ii) garden work or grow vegetables; (iii) read newspaper and/or books; (iv) play cards and/or mahjong; (v) watch television and/or listen to the radio; (vi) raise animals; (vii) participate in social activities; and (viii) travel to other places for pleasure in the past 2 years. All activities were binary (did not perform = 0; performed = 1), and these categories were set by the CLHLS based on the common lifestyle in China.

Functional disabilities

Functional disabilities were assessed by the number of activities of daily living that participants were unable to carry out by themselves. These activities of daily living included dressing, bathing, eating, toileting, getting in or out of bed and continence management.

Statistical analysis

There were 16 540 participants in 2008 and 9765 in 2011. We only included the participants who were aged ≥65 years and had complete data on their cognitive function tests and independent variables. Descriptive statistics were used to describe the characteristics of the sample and the prevalence of cognitive impairment among male and female participants in the old and oldest-old cohorts. Logistic regression models were carried out to examine the gender differences in the odds of having cognitive impairment among the two cohorts. Multinomial logistic regression models were also used to investigate the gender differences in onset of cognitive impairment, and identify factors that could potentially reduce this gender difference. For both logistic and multinomial logistic regression models, the significance of gender differences was compared using six models that introduced independent variables sequentially. Data analysis was carried out with Stata 14.0 (StataCorp, College Station, TX, USA).[11] Odds ratios and relative risk ratios were reported, and a *P*-value of <0.05 was considered statistically significant.

Results

Table 1 details the participants' demographic characteristics and prevalence of cognitive impairment in the old and oldest-old cohorts by gender in 2008. The participants in the old sample ($n = 4063$) were on average aged 72 years, whereas the oldest-old ($n = 9523$) were aged 92 years. A total of 61% of the women in the old sample and 21% of their male counterparts had no formal education, whereas 87% of the oldest-old women and 43% of their male participants had no education. The oldest-old cohort tended to be single (women 92%, men 66%) compared with their old counterparts (women 47%, men 23%), and the social network size also smaller (sibling's visits among the old: 1.7 *vs* 0.4–0.6 for the oldest-old; children's visits among the old: 3.0–3.3 *vs* 2.6–3.0 for the oldest-old). Men participated in leisure activities more than women in general, and the gap became wider among the oldest-old sample. A very small percentage of the old cohort (both sexes 2%) had cognitive impairment compared with the oldest-old female (33%) and male (16%) counterparts.

Table 2 shows the estimated odds ratios (OR) from logistic regressions examining the roles of demographics, SES, social network, leisure activities and functional disabilities in gender differences at baseline cognitive impairment in the old and oldest-old cohorts in the year 2008. No significant gender differences were found in the old cohort regardless of factors that were adjusted in the regression models. However, significant gender differences were found in the oldest-old cohort ($P < 0.001$), indicating the oldest-old women were more likely to be cognitively impaired compared with the oldest-old men. Model 1 showed the crude OR of 2.64, indicating that the oldest-old women were 2.64-fold more likely to have cognitive impairment compared with the oldest-old men. This gender difference was reduced by 1.99 (model 2) after accounting for participants' demographics. Although the odds remained statistically significant, this gender effect decreased the most when the SES variable was introduced (model 3, OR from 1.99 to 1.53). The gender effects were further reduced after introducing social network (model 4 OR from 1.53 to 1.47) and leisure activity (model 5 OR from 1.47 to 1.37) sequentially. The gender differences changed very little; however, when functional disabilities were added into the final model (model 6 OR from 1.37 to 1.36).

Table 3 presents estimated relative risk ratios (RRR) from multinomial logistic regression models investigating gender differences in the onset of cognitive impairment among the old and oldest-old cohorts between 2008 and 2011. Significant gender differences were found in the old cohort, and remained significant when demographics (RRR from 2.21 to 2.18) and SES (RRR from 2.17 to 1.69) were introduced. However, gender differences became insignificant after introducing social network, leisure activities and functional disabilities. Regression models found that the oldest-old women remained at significantly higher risk of having onset of cognitive impairment compared with men ($P < 0.001$), even after introducing all independent variables. Specifically, the crude gender effects were reduced from 2.51 to 2.16 when introducing demographics, and then reduced to 1.71 when incorporating SES. The gender effects were further reduced with social network (RRR

Table 1 Characteristics of the old and oldest-old cohorts by gender in 2008

Variables	Old (n = 4063)		Oldest-old (n = 9523)	
	Female (n/%) (1906/46.9)	Male (n/%) (2157/53.1)	Female (n/%) (5533/58.1)	Male (n/%) (3990/41.9)
Demographics				
Age, years (mean/SD)	72.0/4.3	72.0/4.2	93.2/7.5	90.0/6.6
Rural residence (n/%)	1111/58.3	1305/60.5	3376/61.0	2353/59.0
Socioeconomics				
No formal education (n/%)	1160/60.9	457/21.2	4811/87.0	1719/43.1
Non-agricultural occupations (n/%)	480/25.2	886/41.1	707/12.8	1462/36.6
Social network				
Single (n/%)	902/47.3	488/22.6	5066/91.6	2630/65.9
No. siblings frequently visiting (mean/SD)	1.7/1.7	1.7/1.7	0.4/0.9	0.6/1.0
No. children frequently visiting (mean/SD)	3.3/1.8	3.0/1.7	2.6/1.9	3.0/2.0
Leisure activities (n/%)				
Exercise	703/36.9	966/44.8	1077/19.5	1305/32.7
Garden work or grow vegetables	1545/81.1	1773/82.2	3088/55.8	2704/67.8
Reading newspaper or books	331/17.4	923/42.8	272/4.9	964/24.2
Playing cards and/or mahjong	419/22.0	673/31.2	467/8.4	619/15.5
Watching TV and/or listening to radio	1674/87.8	1987/92.1	3168/57.3	2880/72.2
Raise animals	745/39.1	817/37.9	1069/19.3	787/19.7
Participation in social activities	354/18.6	538/24.9	360/6.5	464/11.6
Travel for pleasure	196/10.3	240/11.1	141/2.5	154/3.9
Functional disabilities				
No. ADL disabilities, 0–6 (mean/SD)	0.1/0.5	0.1/0.5	0.7/1.5	0.4/1.2
Cognitive impairment (n/%)	42/2.2	41/1.9	1822/32.9	626/15.7

Total (N = 13 586). ADL, activities of daily living; SD, standard deviation.

from 1.71 to 1.55), as well as leisure activities (RRR from 1.55 to 1.49); however, the functional disabilities had little effect on gender differences (RRR from 1.49 to 1.48).

Table 4 presents the gender effects on risk of death and lost to follow up relative to being cognitively normal among the old and oldest-old cohorts from 2008 to 2011. Significant gender differences in mortality existed among those who were cognitively normal at baseline in both the old and oldest-old cohorts. Specifically, the old and oldest-old men were significantly more likely to pass (RRR 0.60 and 0.63, respectively) than their female counterparts after controlling for all the independent variables. However, gender differences were not significant in the likelihood of lost to follow up among those who were cognitively normal at baseline.

Discussion

The present study examined gender differences in cognitive function in the old (aged 65–79 years) and oldest-old (aged 80 and 116 years) men and women in China. We compared the prevalence rates of cognitive impairment and gender differences in multiple years. Furthermore, we attempted to identify variables that could reduce possible gender differences in cognitive impairment. Similar to a previous study, the oldest-old women were found to be at the highest risk of having cognitive impairment compared with the old men, old women and the oldest-old men.[5]

The results of logistic regression showed that when introducing SES, the disparities between men and women were reduced significantly, indicating the possible effects of education and occupation on the prevalence of cognitive impairment. Reflecting the historical events in China, it is critical to consider distinct experiences that each age cohort went through and might influence the cohort's cognition in their later lives. Most Chinese women did not have any access to formal education before 1949. In 1949, the vast majority of women in the old cohort were between the ages of 3 and 17 years; by then, many of them might have grown out of their primary education years, which is reflected in the high percentage of women with no formal education in the old cohort (61%). Even if they were of a younger age and were able to receive formal education, this does not guarantee that women in the old cohort were in a situation that they had access or the ability to attend school at year 1949. The oldest-old women did not have a chance to have education, because they were aged between 18 and 38 years in 1949, presenting an even higher rate of no formal education (87%). In terms of occupation, the old and oldest-old women were financially supported by men, because they did not have access or earning opportunities under the traditional feudal society. Associations between formal education and age-related cognition have been studied extensively over many decades in a variety of geographic areas.[12–14] Although the results of these associations vary, many have been shown to support protective factors of education toward cognitive decline with longitudinal,[15] as well as cross-sectional studies.[13,16] The lack of formal education and occupational opportunities have certainly left the old and, especially, the oldest-old women in disadvantaged positions in China.

The results show a reduction of the risk of having cognitive impairment when having broader social networks. A cognitively stimulating environment is one protective factor that has been suggested and previously tested in older men and women in Latin America and Caribbean countries.[17,18] As women were restricted to live in the same living quarters with their families in China, their exposure to stimulating environments might have been limited. Wider social networks and frequent contact with people positively influenced the maintenance of cognition, especially for women in the USA, Korea and Spain.[19–22] Lee and Kim's study supports the present findings; a positive association between frequent phone and face-to-face contact with offspring and cognitive decline among Korean older adults in Korea.[23]

In addition to education and social network, the present study showed that engaging in leisure activities was another environmental factor that protected against the risk of cognitive impairment among men. This result was supported by earlier studies,

Table 2 Estimated odds ratios of gender difference in cognitive impairment among the old and oldest-old cohorts in the year 2008

Variables	Old (OR)						Oldest-old (OR)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Demographics												
Gender (ref: male)	1.16	1.16	0.78	0.75	0.65	0.67	2.64***	1.99***	1.53***	1.47***	1.37***	1.36***
Age (years)		1.16***	1.15***	1.13***	1.10**	1.09**		1.11***	1.11***	1.10***	1.08***	1.07***
Residence (ref: urban)		3.39***	2.48**	2.59**	1.98*	2.32*		1.26***	1.08	1.09	1.05	1.14*
Socioeconomics												
Education (ref: no education)			0.48**	0.49**	0.69	0.61			0.61***	0.61***	0.70***	0.69***
Occupations (ref: agriculture)			0.58	0.58	0.70	0.68			0.70***	0.70***	0.82*	0.74***
Social network												
Marital status (ref: married/partnered)				0.71	0.78	0.79				0.84*	0.88	0.87
No. siblings with frequent visits				0.85	0.88	0.87				0.93*	0.95	0.95
No. children with frequent visits				0.87*	0.90	0.88*				0.95***	0.95***	0.95**
Leisure activities (ref: did not perform)												
Exercise					0.89	0.96					0.78**	0.85*
Garden work, grow vegetables					0.49**	0.71					0.60***	0.75***
Reading newspaper or books					0.32*	0.35					0.69**	0.71**
Playing cards and/or mahjong					0.26*	0.31*					0.40***	0.43***
Watching TV and/or listening to radio					0.36***	0.44**					0.55***	0.58***
Raise animals					0.50**	0.63					0.55***	0.62***
Participation in social activities					0.81	0.81					0.79	0.79
Travel for pleasure					0.97	0.98					1.02*	1.70
Functional disabilities						1.79***						1.37***

*$P < 0.05$ **$P < 0.01$ ***$P < 0.001$ Model 1: gender difference; model 2: gender difference + demographics; model 3: gender difference + demographics + SES; model 4: gender difference + demographics + SES + social network; model 5: gender difference + demographics + SES + social network + leisure activity; model 6: gender difference + demographics + SES + social network + leisure activity + functional disabilities. OR, odds ratio.

Table 3 Estimated relative risk ratios of gender difference in the onset of cognitive impairment among the old and oldest-old cohorts in the year 2011

Variables	Old (RRR)						Oldest-old (RRR)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Demographics												
Gender (ref: male)	2.21***	2.18***	1.70*	1.60	1.48	1.48	2.51***	2.16***	1.71***	1.55***	1.49***	1.48***
Age (years)		1.19***	1.18**	1.17***	1.15***	1.15***		1.08***	1.08***	1.07***	1.06***	1.06***
Residence (ref: urban)		1.30	1.15	1.11	1.06	1.07		1.33**	1.18	1.18	1.11	1.13
Socioeconomics												
Education (ref: no education)			0.60*	0.61*	0.71	0.71			0.65***	0.66***	0.73**	0.72**
Occupations (ref: agriculture)			0.87	0.91	1.06	1.06			0.78	0.80	0.89	0.86
Social network												
Marital status (ref: married/partnered)				0.85	0.89	0.88				0.63***	0.64**	0.64**
No. siblings frequently visiting				1.01	1.01	1.01				0.89*	0.89*	0.89*
No. children frequently visiting				1.09	1.09	1.09				1.00	1.01	1.01
Leisure activities (ref: did not perform)												
Exercise					0.66	0.67					0.88	0.90
Garden work, grow vegetables					1.19	1.22					0.88	0.94
Reading newspaper or books					0.65	0.65					0.75	0.75
Playing cards and/or mahjong					0.89	0.90					0.75*	0.77
Watching TV and/or listening to radio					0.51*	0.52*					0.84	0.85
Raise animal					0.63*	0.64					1.09	1.12
Participation in social activities					1.07	1.07					1.10	1.10
Travel for pleasure					0.85	0.85					0.81	0.81
Functional disabilities						1.25						1.34***

*$P < 0.05$ **$P < 0.01$ ***$P < 0.001$ Model 1: gender difference; model 2: gender difference + demographics; model 3: gender difference + demographics + SES; model 4: gender difference + demographics + SES + social network; model 5: gender difference + demographics + SES + social network + leisure activity; model 6: gender difference + demographics + SES + social network + leisure activity + functional disabilities. RRR, relative risk ratio.

Table 4 Estimated relative risk ratios of gender difference in deaths and lost to follow up among the old and oldest-old cohorts in the year 2011

Variables	Deaths *vs* cognitively normal (model 6)		Lost to follow up *vs* cognitively normal (model 6)	
	Old (RRR)	Oldest-old (RRR)	Old (RRR)	Oldest-old (RRR)
Demographics				
Gender (ref: male)	0.60***	0.63***	1.13	1.07
Age (years)	1.15***	1.10***	1.00	1.06**
Residence (ref: urban)	1.09	1.22**	0.67**	0.58**
Socioeconomics				
Education (ref: no education)	1.01	0.90	0.97	0.88
Occupations (ref: agriculture)	0.93	1.05	1.83***	1.51***
Social network				
Marital status (ref: married/partnered)	0.88	0.70***	0.78*	0.66***
No. siblings with frequent visits	0.94	0.92**	1.06*	0.91*
No. children with frequent visits	0.97	1.01	0.95	0.97
Leisure activities (ref: did not perform)				
Exercise	0.64**	0.82**	0.86	0.84*
Garden work, grow vegetables	1.21	0.87*	1.34	1.13
Reading newspaper or books	0.78	0.75**	1.03	1.08
Playing cards and/or mahjong	1.12	0.71***	1.11	0.93
Watching TV and/or listening to radio	0.67*	0.73***	0.85	0.84*
Raise animal	1.06	1.01	0.72**	0.88
Participation in social activities	1.11	0.90	1.14	1.09
Travel for pleasure	1.01	0.93	0.99	1.03
Functional disabilities	1.64***	1.46***	1.44**	1.42***

*$P < 0.05$ **$P < 0.01$ ***$P < 0.001$ Model 6: gender difference + demographics + SES + social network + leisure activity + functional disabilities. RRR, relative risk ratio.

including studies from China, showing positive effects of involvement in cognitively challenging leisure activities.[12,24] Functional disabilities had a very small impact on gender differences. This is easily understandable, as disabilities naturally increase as people age, regardless of gender.[25]

The strengths of the study included the use of a large, longitudinal, population-based dataset (n = 13 586); comparing the old and oldest-old cohorts; and exploring the mediating roles of SES, social network, leisure activities and functional disabilities in gender differences in cognitive impairment. However, the present study had limitations. The dataset was limited to using a brief epidemiological screening instrument (Chinese MMSE) for cognitive function rather than a comprehensive clinical evaluation. The instrument might lack the sensitivity to detect the early stage of cognitive impairment at the baseline or capture the onset of cognitive impairment at follow up. In addition, approximately half of the participants were lost to follow up (16%) or died (31%) before the 2011 follow up, and there was little information about the reasons. These participants might have also been cognitively impaired due to risk factors that could not be assessed at the follow up. Although we have identified potential variables that might alleviate the gender disparities, other factors could contribute to gender disparities that are not assessed in the current study. Although the CLHLS is a large longitudinal dataset, the present study is based on a secondary data analysis, and therefore, the ability of data analysis was limited to only the available variables that had been collected.

The findings suggest that the oldest-old women had a higher risk of having cognitive impairment than the old men, women and the oldest-old men in China. Given the environments and situations that women in the oldest-old cohort have endured throughout their lives, their highest risk of cognitive decline might have been unavoidable. Investment in women's educational attainment, spending an active lifestyle in a stimulating environment and involvement in cognitively challenging activities might help alleviate gender disparities. For future research, we should pay close attention to the current old cohort of men and women, who have not developed cognitive impairment, but will face their oldest-old age in the near future, because according to life-course perspectives, later cohorts that potentially possess higher cognitive functions will replace older cohorts with poor cognitive performance.[17,26] We need to follow this old cohort to see if they develop cognitive impairment as high as the current oldest-old cohort, especially women, as the majority of old women still did not have access to formal education. For that reason, we might need to follow current middle-aged men and women in China who have had the full advantages of formal education, as well as employment opportunities, to explore if their life environments would make any differences in the onset of cognitive impairment as they age. If there are gender differences in the prevalence of cognitive impairment among the middle-aged men and women, it might mean that other factors could have a greater influence than education on gender differences. If there is no difference, then education might be the reason for the gender difference. It will take a couple of decades; however, by following these cohorts longitudinally, we might be able to find potential long-term solutions to gender disparities in cognitive impairment in China.

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Disclosure statement

The authors declare no conflict of interest.

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