FACTORS ASSOCIATED WITH COGNITIVE DECLINE AMONG ELDERLY IN WUHAN, CHINA LIVING ALONE VERSUS THOSE LIVING WITH CHILDREN

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Abstract. In this study, we aimed to compare cognitive function between elderly living alone (empty-nest) with elderly living with children (non-empty-nest) in Wuhan, China. We also aimed to determine factors associated with lower cognitive function. We used a self-compiled scale to investigate demographic characteristics, life style factors, and chronic diseases. We used the Beijing version of the Montreal Cognitive Assessment scale (MoCA-BJ) to evaluate cognitive function. We used multiple liner regression analysis to explore the factors associated with cognitive decline. A total of 1,210 elderly were included in the study, 55% female. Empty-nest elderly had a higher MoCA-BJ score (22.3 ± 4.8) than non-empty-nest elderly (21.7 ± 5.2), but this difference was not significant. Multiple linear regression analysis showed older age, lower education level, poorer ability to perform activities of daily living, and having more chronic diseases were associated with lower cognitive function among both empty-nest and non-empty-nest elderly; female gender and lower bonding social capital were associated with lower cognitive function among non-empty-nest elderly; being single, smoking, having no social insurance, and having lower bridging social capital were associated with lower cognitive function among empty-nest elderly. Our findings did not show a significant cognitive difference between empty-nest and non-empty nest subjects but did find factors associated with lower cognitive function. Healthcare providers need to keep these factors associated with lower cognitive function in mind when evaluating and treating this study population.

Keywords: empty-nest elderly, cognitive decline, non-empty-nest elderly, urban community

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INTRODUCTION

By the end of 2015, the population of China was 1.37 billion, those aged ≥65 years accounted for 10.5% of the total population (National Bureau of Statistics of China, 2016). China has the largest elderly population in the world. Many

families have only one child due to the governmental one-child policy for the last 30 years (Pan, 2006). The aging population and one-child policy have resulted in many elderly with no children living with them (Wang *et al*, 2013). The term ''empty-nest elderly'' has been used in China to refer to those elderly without children or those with children who have already left their care (Liang and Wu, 2014). The empty-nest elderly usually live alone or with their spouses only. According to the "China Longitudinal Aging Social Survey (CLASS)", empty-nest elderly accounted for 47.5% of the elderly population in China in 2016, and are expected to reach 90% by 2030 (Chang *et al*, 2016). Shrinking social resources and lack of emotional support for this group could result in empty-nest elderly being at greater risk for health problems than non-empty-nest elderly (Silverstone and Hyman, 2008).

Cognitive decline is a symptom of Alzheimer's disease (AD) and other dementias. Decline in cognitive function affects older adults' quality of life and increases the burden on their family and society (Lara *et al*, 2017). Poor cognitive function can result in inability to perform activities of daily living (Opara, 2012) and reduce life expectancy (Smits *et al*, 1999). It is important to determine if it is possible to prevent or delay cognitive decline at personal and public health levels. There are many studies of cognitive decline in the elderly, but few compare empty-nest with non-empty-nest elderly (Xie *et al*, 2010; Guo *et al*, 2016). However, factors associated with cognitive decline in empty-nest elderly have been rarely reported in China. We hypothesize empty-nest elderly are at greater risk for cognitive decline than non-empty-nest elderly and there may be factors that differ between the two groups. The aim of this study was to compare cognitive health among empty-nest and non-empty-nest elderly and investigate possible factors that differ between two groups in order to inform further studies to try modifying those factors to reduce risk of cognitive decline in elderly.

MATERIALS AND METHODS

Study design

We conducted a cross-sectional community-based study in July 2014 in Wuhan City, Hubei Province, China. This city has a geographic area of 8,494.41 km^2. and a total population of 10.33 million at the end of 2014 (Wuhan statistical yearbook, 2015).

Participants

Our target population were the elderly living in urban areas. Inclusion criteria were: those aged ≥65 years; living in Wuhan for at least 6 months, who were willing to participate in the study. Exclusion criteria were those with severe dementia, schizophrenia, or other severe mental disorders with severe vision, hearing, or speaking difficulty; who had a severe movement disability or were unable to have normal social interaction. Stratified cluster sampling was used to recruit participants. Two of the 13 districts in Wuhan City were chosen for the study site. One subdistrict was randomly selected from each study district, and 3 neighborhoods were randomly selected from each subdistrict. A total of 1,498 residents were chosen to participate (149 could not be reached, 79 refused to participate and 60 were not able to complete the questionnaire); 1,210 subjects were included in the study.

The investigators for this study were graduate students from the School of Health Sciences, Wuhan University, who had been trained for this study. Each subject gave informed consent before participating in the study. Subjects were

classified as empty-nest elderly if their child or children did not live with them. It was also recorded if they lived alone or with a spouse.

Study instruments

Beijing version of Montreal Cognitive Assessment (MoCA-BJ). The Montreal Cognitive Assessment-Beijing version (MoCA-BJ) was used to evaluate different cognitive domains because of its high sensitivity and specificity for detecting cognitive decline (Nasreddine *et al*, 2005). The MoCA-BJ examines the following cognitive domains: 1) visuospatial abilities; 2) executive function; 3) attention and concentration; 4) memory; 5) language; 6) conceptual thinking; 7) calculations; and 8) orientation. The MoCA-BJ has been most widely used in China, and its reliability and validity have been tested (Chen *et al*, 2015). The MoCA-BJ has a possible score of 0-30 points, with higher scores indicating better cognitive function.

Personal Social Capital Scale-16. Social capital is defined as the resources accessed through social networks and social participation (Coleman, 1990). Previous studies have linked social capital to a number of health outcomes (Murayama *et al*, 2012), including cognitive function (Wang *et al*, 2016). In our study, social capital was assessed using the Chinese version of the Personal Social Capital Scale (PSCS-16), which consists of 16 items covering two key social capital domains, bonding social capital and bridging social capital. Bonding social capital was defined as "relationships within homogeneous groups (*ie*, strong ties that connect family members, neighbors, and close friends)" (Islam *et al*, 2006). Bridging social capital was defined as "links between individuals/groups in different structural positions of power (*ie*, weak ties that link different ethnic and occupational backgrounds); can refer to links above and below" (Islam *et al*, 2006). The PSCS-16 has been found to be reliable and valid in China (Wang *et al*, 2014). Bonding social capital was accessed by four dimensions: 1) the number of friends and country fellows/old classmates; 2) network members (*ie*, relatives and coworkers/fellows), whom you trust; 3) the number of network members possessing resources including professional job and social influence, and 4) the number of network members who will help you upon request. Bridging social capital was accessed by four dimensions: 1) the number of cultural, recreational, leisure groups/organizations in your community; 2) the number of these groups or organizations that possess broad social connections and have social influence; 3) the number of these groups or organizations represent your interests; 4) the number of these groups or organizations that will definitely help you upon request. Each dimension contained two questions, and these questions were assessed using a 5-point Likert scale. The total score of each social capital domain (bonding/bridging social capital) ranges from 8 to 40 points and higher scores indicate greater social capital (Wang *et al*, 2014).

Activities of Daily Living Scale. Daily living activities were assessed using the Activities of Daily Living Scale (ADLs), which included the Physical Self-maintenance Scale (PSMS) and the Instrumental Activities of Daily Living Scale (IADL) (Lawton and Brody, 1969). The PSMS includes using the toilet, eating, dressing, washing, walking and bathing. The IADL includes telephone use, going shopping, cooking, doing daily housework, using public transportation, washing clothes,

taking medicine, and management of own finances. Each question had 4 responses: "I can do it by myself", "I have some difficulties", "I need help" and "I cannot do it". Subjects who had difficulty with any of the items were classified as having functional decline (Qian and Ren, 2016).

Social-demographic factors. Age, marital status, having social insurance or not, and education level were recorded. Education was classified into 4 categories: no formal education, primary school, high school, and college education. Lifestyle factors included smoking, alcohol drinking, and exercise. Cigarette smoking, and alcohol drinking were classified as never used, used in the past, and currently uses. Subjects who did exercise at least three times a week for 30 minutes were classified as being physically activity, and those who exercised less than this or not at all were classified as being physically inactivity. Each subject was asked about a history of hypertension, cardiovascular disease, cerebrovascular disease, hyperlipidemia, and diabetes mellitus.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS), version 20.0 (IBM, Armonk, NY). A 95% confidence interval (CI) was used with significance set at $p < 0.05$. Chi-square tests were used to explore univariate relationships between cognitive function and the following: age, marital status, having social insurance, education level, income, history of smoking, alcohol drinking, number of chronic diseases, ADL, and bonding/bridging social capital scores. Multiple liner regression analysis was used to explore factors associated with cognitive decline among both empty-nest and non-empty-nest elderly.

Ethical considerations

This study was approved by the Ethics Committee, School of Health Sciences, Wuhan University.

RESULTS

General characteristics of study subjects

A total of 1,210 subjects were included in the study; 55.5% females. The mean subject age was 74.3 ± 6.1 years. Sixty-four point two percent of subjects were currently married. Thirty point three percent had a primary education and 42.9% had a high school education. Eighty-four percent of participants were nonsmokers and 83.8% were nondrinkers. Seventy point nine percent of subjects were physically activity. The mean (standard deviation) number of chronic diseases was 0.8 (± 0.6). Twenty point six percent of participants were dependent on others for activities of daily living.

Sixty point eight percent were empty-nest elderly. Empty-nest subjects were more likely than non-empty nest subjects to be male, married, have a higher education level, be nondrinkers and have normal ADL, higher cognitive scores, higher bonding scores and higher bridging social capital scores (Table 1).

Factors associated with cognitive decline among non-empty-nest elderly

Multiple linear regression analysis found older age was associated with lower cognitive function (B = -0.168, p<0.001). Females had lower cognitive function than males (B = -0.866, p=0.044). Higher education level was associated with higher cognitive functioning compared to having a primary education level (B = 2.426, p<0.001). Having more chronic diseases was associated with lower cognitive function (B = -0.634, p=0.037). Functional

Table 1
General characteristics of empty-nest and non-empty-nest subjects.

Characteristic	Total (*N*=1,210)	Empty-nest (*n*=736)	Non-empty-nest (*n*=474)	*p*-value
Mean ± SD, age in years,	74.3 ± 6.1	74.5 ± 6.0	74.2 ± 6.3	0.265
Gender, *n* (%)				
Male	538 (44.5)	356 (48.4)	182 (38.4)	0.001
Female	672 (55.5)	380 (51.6)	292 (61.6)	
Marital status, *n* (%)				<0.001
Married	797 (64.2)	553 (75.1)	244 (51.5)	
Single	413 (38.5)	183 (24.9)	230 (48.5)	
Education level, *n* (%)				0.001
No formal education	198 (16.4)	111 (15.1)	87 (18.4)	
Primary education	367 (30.3)	200 (27.2)	167 (35.2)	
High school	519 (42.9)	337 (45.8)	182 (38.4)	
College or above	126 (10.4)	88 (12.0)	38 (8.0)	
Insurance, *n* (%)				0.253
Yes	1,184 (97.9)	723 (98.2)	461 (97.3)	
No	26 (2.1)	13 (1.8)	13 (2.7)	
Smoking, *n* (%)				0.675
Never	1,017 (84.0)	616 (83.7)	401 (84.6)	
Current /Past	193 (16.0)	120 (16.3)	73 (15.4)	
Alcohol consumption, *n* (%)				0.016
Never	1,014 (83.8)	608 (82.6)	406 (85.7)	
Current /Past	196 (16.2)	128 (17.4)	68 (14.3)	
Exercise, *n* (%)				0.238
Physical activity	858 (70.9)	531 (72.1)	327 (69.0)	
Physical inactivity	352 (29.1)	205 (27.9)	147 (31.0)	
Number of chronic diseases, Mean ± SD	0.8 ± 0.6	0.8 ± 0.6	0.7 ± 0.6	0.377
ADL, *n* (%)				0.007
Completely normal	961 (79.4)	603 (81.9)	358 (75.5)	
Functional decline	249 (20.6)	133 (18.1)	116 (24.5)	
Mean ± SD, Bonding social capital, score	28.1 ± 6.3	27.5 ± 6.1	29.2 ± 6.5	0.044
Bridging social capital, score	15.5 ± 5.9	16.0 ± 6.1	14.8 ± 5.5	0.020
Mean ± SD, Cognitive function, score	22.1 ± 4.9	22.3 ± 4.8	21.7 ± 5.2	0.140

ADL, activities of daily living; SD, standard deviation.

decline was associated with higher risk of cognitive decline (B = -3.036, $p<0.001$). A lower bonding social capital score was associated with lower cognitive functioning among non-empty-nest subjects (B = 0.103, $p=0.001$) (Table 2).

Factors associated with cognitive decline among empty-nest elderly

Multiple linear regression analysis found older age was associated with lower cognitive function (B = -0.172, $p<0.001$). Among empty-nest elderly, being single

Table 2
Multiple linear regression analysis on the potential factors associated with cognitive decline among non-empty-nest subjects (n=474).

	B (95% CI)	SE	Beta	p-value
Age	-0.168 (-0.232,-0.105)	0.032	-0.206	<0.001
Gender (ref: Male)				
Female	-0.866 (-1.707,-0.025)	0.428	-0.082	0.044
Marital status (ref: Married)				
Single	0.795 (-0.009,1.599)	0.409	0.077	0.053
Education level (ref: No formal education)				
Primary education	2.426 (1.421,3.431)	0.511	0.218	<0.001
High school	4.874 (3.855,5.893)	0.518	0.470	<0.001
College or above	6.664 (4.394,8.980)	1.178	0.203	<0.001
Social insurance (ref: No)				
Yes	0.449 (-1.622,2.519)	1.054	0.014	0.670
Smoking (ref: Never)				
Current /Past	-0.443 (-1.477,0.591)	0.526	-0.031	0.400
Alcohol consumption (ref: Never)				
Current /Past	0.305 (-0.734,1.344)	0.529	0.021	0.564
Exercise (ref: Physical activity)				
Physical inactivity	0.344 (-0.551,1.238)	0.455	0.027	0.451
Number of chronic diseases	-0.634 (-1.231,-0.037)	0.304	-0.070	0.037
ADL (ref: Completely normal)				
Functional decline	-3.036 (-3.901,-2.171)	0.440	-0.272	<0.001
Bonding social capital	0.103 (0.042,0.165)	0.031	0.129	0.001
Bridging social capital	-0.039 (-0.101,0.022)	0.031	-0.046	0.210

R^2 = 0.504, Adjusted R^2 = 0.489
ADL, activities of daily living; Ref, reference; B, unstandardized coefficients; CI, confidence interval; SE, standard error; Beta, standardized coefficients.

was associated with cognitive function, (B = -0.749, p=0.029). Higher education level was associated with higher cognitive function (B = 3.227, p<0.001). Subjects with social insurance had higher cognitive function (B = 2.813, p=0.008). Smokers had lower cognitive function (B = -1.048, p=0.013). Having more chronic diseases was associated with lower cognitive function (B = -0.483, p=0.042). Overall functional decline was associated with lower cognitive function (B = -2.276, p<0.001). Having higher bridging social capital was associated with higher cognitive function among empty-nest subjects (B = 0.053, p=0.041) (Table 3).

DISCUSSION

In our study, the overall MoCA scores among our study (22.1 ± 4.9) was lower than that of previous studies (24.8, 23.8) (Coen *et al*, 2011; Li *et al*, 2017). This might be due to a lower education level among our study subjects or a higher average age of our study subjects. Our data showed

Table 3
Multiple linear regression analysis of potential factors associated with lower cognitive function among empty-nest subjects (*N*=736).

	B (95% CI)	SE	Beta	*p*-value
Age	-0.172 (-0.222,-0.122)	0.025	-0.215	<0.001
Gender (ref: Male)				
Female	-0.439 (-1.086,0.208)	0.329	-0.046	0.183
Marital status (ref: Married)				
Single	-0.749 (-1.423,-0.075)	0.343	-0.069	0.029
Education level (ref: No formal education)				
Primary education	3.227 (2.374,4.079)	0.434	0.295	<0.001
High school	4.933 (4.414,5.726)	0.404	0.516	<0.001
College or above	5.170 (3.787,6.553)	0.704	0.239	<0.001
Social insurance (ref: No)				
Yes	2.813 (0.723,4.904)	1.065	0.078	0.008
Smoking (ref: Never)				
Current /Past	-1.048 (-1.871,-0.226)	0.419	-0.081	0.013
Alcohol consumption (ref: Never)				
Current /Past	0.369 (-0.436,1.174)	0.410	0.029	0.369
Exercise (ref: Physical activity)				
Physical inactivity	-0.266 (-1.013,0.481)	0.381	-0.021	0.485
Number of chronic diseases	-0.483 (-0.948,-0.018)	0.237	-0.059	0.042
ADL (ref: Completely normal)				
Functional decline	-2.276 (-2.960,-1.592)	0.348	-0.202	<0.001
Bonding social capital	0.038 (-0.013,0.088)	0.026	0.048	0.145
Bridging social capital	0.053 (0.002,0.104)	0.026	0.066	0.041

$R^2 = 0.409$, Adjusted $R^2 = 0.397$
ADL, activities of daily living; Ref, reference; B, unstandardized coefficients; CI, confidence interval; SE, standard error; Beta, standardized coefficients.

that the status of cognitive function in empty-nest elderly was better than that in non-empty-nest elderly, but this difference was not significant. This is not consistent with what we hypothesized. One reason may be that, with the progress of society and economic situation, especially in urban areas, the living standards of elderly have been improved. The elderly were more likely to go together to participate in social activities after retirement, such as dancing, travelling, or going to senior university (Ye *et al*, 2016), Participation in social activities could help empty-nest elderly maintain their social network and social resource (Hsu, 2007), which have beneficial effects on cognitive function (Wang *et al*, 2016). Another possible reason may be that empty-nest elderly have higher education level than non-empty-nest elderly, and higher education level has positive effects on cognitive function among elderly (Thow *et al*, 2017).

Our findings show that older age, lower education level, poor ability to perform ADL and the number of chronic

diseases were factors associated with lower cognitive function among both non-empty-nest and empty-nest study subjects, similar to the findings of previous studies (Lopez *et al*, 2003; Tervo *et al*, 2004). The elderly are more likely to develop geriatric diseases and have poorer social adaptation, which could lead to lower cognitive levels. Elderly with high education levels can read newspapers and books and may have a richer spiritual and cultural life, possible affecting cognitive function. Education level may stimulate cognitive abilities, such as logical reasoning, abstract thinking, and play a role in preventing neuronal connection loss and strengthening neuronal association (Banks and Mazzonna, 2012). Elderly with more chronic diseases are not only more fragile physically but also psychologically and cognitively. In our study, poor functioning on ADL was associated with lower cognitive functioning among study subjects. This is similar to previous studies (Riddle *et al*, 2015; Chen and Liu, 2017).

In our study among non-empty-nest subjects, females had lower cognitive function than males, but not among empty-nest elderly. This may be because living with their children, empty-nest female can communicate with their children any time, which was a good way to lessen anxiety (Guo *et al*, 2016), and anxiety might lead to poor cognitive function (Paterniti *et al*, 1999).

Not having social insurance was a risk factor for cognitive decline among empty-nest subjects but not non-empty-nest subjects. A reason for this is that, in China empty-nest elderly often have a tighter budget because their main financial sources are from their pension. This may lead to anxiety which can be associated with lower cognitive function (Barnes *et al*, 2006). However, non-empty-nest subjects have other forms of economic support from their children and have less concern about their budget.

In our study, empty-nest subjects who were married had better cognitive function than those who were not married. This may be because empty-nest subjects who were married received emotional support from their spouse even without having children in the home. Emotional support may help empty-nest elderly maintain better cognitive function (Zamora-Macorra *et al*, 2017).

In our study, smoking was associated with lower cognitive function among empty-nest subjects but not non-empty-nest subjects. Tuon *et al* (2010) found smoking can accelerate brain atrophy and degeneration which result in cognitive decline. However, a 10-year cohort study reported smoking may be protective against cognitive decline (Wang *et al*, 2010). Broe *et al* (1998) found no association between smoking and cognitive decline. Liu *et al* (2002) found heavy smoking was associated with cognitive decline, while a medium level of smoking was protective against cognitive function among elderly. Empty-nest elderly are more likely to be heavy smokers (Mao and Yin, 2015). The effects of smoking on cognitive function in non-empty-nest and empty-nest elderly need further studies especially in regard to the amount of tobacco smoked.

The lower bonding social capital score in our study was associated with lower cognitive function among non-empty-nest subjects, but not among empty-nest subjects. Bonding social capital refers to links among residents in a community whose social identities are similar (homogeneous social networks). The non-empty-nest subjects have higher bonding

social capital scores than empty-nest subjects, so they tended to have more social trust and aid from homogeneous social networks than heterogeneous social networks. Stronger homogeneous social networks can promote dissemination of health information and encourage healthy behavior among those with similar socio-demographic characteristics (Kawachi and Berkman, 2000). The lower bridging social capital score was associated with lower cognitive function among empty-nest subjects but not among non-empty-nest subjects. Bridging social capital refer to links among members of a community whose status and power are different from each other (heterogeneous social networks) (Kawachi *et al*, 2004), and mainly measured as the perception of community groups and assistance obtained from social organizations in our study. The empty-nest subjects have higher bridging social capital scores than non-empty-nest subjects, so they tended to have more opportunity to participate in social activities. Bridging social capital may be directly associated with cognitive function through social participation (Fu *et al*, 2017). Social participation may involve individuals in joining some community organizations and sports clubs, which have benefit effects on cognitive function (Fu *et al*, 2018).

In conclusion, this study found that the status of cognitive function was better in empty-nest subjects than in non-empty-nest subjects, but this difference was not significant. This study also found that factors associated with cognitive function among empty-nest and non-empty-nest subjects are different, healthcare providers need to keep these factors in mind when evaluating and treating this study population.

Our study had limitations. First, since this was a cross sectional survey study, we could not investigate causal relationships of cognitive decline, only cognitive function. Second, our finding based on self-reports, which is at risk for bias due to false or inaccurate responses from the participants. Third, data for this study came from a single urban area in Wuhan City. Therefore, these results cannot be generalized to other populations.

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