

# The association between intrinsic capacity and activities of daily living among older adults in China

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## Research article

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# Abstract

**Background:** The Intrinsic capacity (IC) has been considered the core of older adults' functional ability. However, there is little study on IC from China, Asia. **Methods:** Data were drawn from the Long-term Care Demand Assessment (LCDA), a population-based face-to-face survey of 60 years old or over from Southern, Western, Central, Northern, Eastern China. **Results:** A total of 2016 individuals were included in the final analysis. Independent variables were composed of demographic characteristics, four IC domains, health-related factors, and common diseases. The outcome was known as activities of daily living (ADL). Logistic regression analysis was used to explore the association between IC and ADL. Univariate analysis showed that each IC domains were significantly associated with ADL. Multivariate analysis showed that the association between sensory function and ADL was not stable. Nursing home elders (odds ratio [OR] = 0.58; 95% confidence interval [CI] 0.52-0.64) with low nutrition score were more likely to have ADL impairment than community dwellers (OR = 0.86, 95%CI 0.80-0.13). Community dwellers with depression were more likely to suffer ADL impairment (OR = 1.11, 95%CI 1.07-1.14). **Conclusion:** IC is the core of the ADLs among Chinese older adults. However, the magnitude of the contribution of each IC domain to ADL is partly influenced by living conditions.

## Background

Once chronic diseases and co-morbid chronic diseases are considered highly prevalent in old age and to confer high disability, hospitality, and mortality. However, a nationally representative survey of older adults aimed at examining the epidemiology of chronic diseases and disability among older adults in the US revealed that even though multiple chronic diseases are increasingly prevalent, the prevalence of disability showed a decreased trend[1]. This downward disability and upward chronic disease trends were also seen in national investigation several years ago[2], which may be due to improvement in medical service and self-management[3]. Therefore, modern public health management should be proposed to optimize trajectories of older adults' physical capacities instead of trying to manage an array of diseases and treat specific symptoms in a disjointed fashion.

Recently, an innovative public health model in the 'World Report on Ageing and Health' proposed by the World Health Organization (WHO) considers healthy ageing from functional rather than a disease-based perspective[4]. Functional ability is made up of three components and one essential element is the intrinsic capacity (IC). Briefly, IC is a comprehensive indicator to evaluate the older people's physical and mental health status and it is composed of five domains that are cognition, depression, mobility, nutrition and hearing and visual function[4–6]. These five domains of IC are initiated and testified via statistical analysis of data from the English Longitudinal Study of Ageing (ELSA), Toulouse Frailty Clinic (France), and Hertfordshire Ageing Study (UK). Additionally, the other two components are the environmental characteristics and the interaction between them and IC[6].

The loss of IC could result in activities of daily living (ADL) impairment and a significant decline in IC leads to observable inability without assistance. Therefore, IC is considered as the main core of ADL and

combines with environmental factors to influence the old people's ADL and dependency. However, IC is suggested by data from Europe and America and the potential factors in these data might not be sufficient[6], so it is unclear whether it is suitable for Asians. Moreover, it is unclear whether the contribution of IC to ADL is different in uncommon living conditions, like nursing home elders or community-dwelling elders. Therefore, this study will first make use of data from China to study the association between IC and ADL and then explore how each IC domain associated with ADL among community dwellers and nursing home elders.

## Methods

### *Participants*

Data were drawn from the Long-term Care Demand Assessment (LCDA), a population-based face-to-face survey of 60 years old or over from rural and urban areas of China. A multistage, cluster sampling scheme was conducted by the Xiangya-Oceanwide Health Management Research Institute, Central South University. Initially, four regions (Hunan, Jiangsu, Tianjin, and Heilongjiang) were randomly selected from the northern, southern, central, western, and eastern regions, respectively, of China. Then, cities with a representative population and economic development were selected (Changsha, Changde, Zhuzhou, Xiangtan, Hengyang, Nantong and Daqing). Finally, communities and nursing homes from these places were selected randomly. A total of 3340 individuals were enrolled in this project. Then, a total of 1324 individuals were excluded due to coma (141), missing depression data (872), disability (224), Alzheimer's disease (63) and other dementia (24), resulting in 2016 participants included in this analysis. This study was approved by the Central South University Ethics Committee (approval number: 2018011). All participants provided written informed consent at the time of enrollment.

### Measures

*Functional ability* The Barthel Index (BI) was used to measure the individuals' level of dependency in ADL. The BI is a sum score across ten domains of ADL. Each domain is scored on a weighted numerical scale with the lowest score indicating total dependency and the highest score indicating complete independence. The minimum total score is 0 (completely dependent), the maximum total score is 100 (completely independent). Time for completion is approximately 5-10 minutes[7].

### *Intrinsic capacity*

*Depression* The patient health questionnaire depression scale (PHQ-9) was used to measure the individual's depressive symptoms. As a severity measure, the PHQ-9 score ranges from 0 to 27, since each of the 9 items can be scored from 0 (not at all) to 3 (nearly every day)[8].

*Nutrition* The Mini Nutritional Assessment short-form (MNA-SF) was used to measure the individual's nutritional status. It consists of an ordinal scale with values ranging from 0-14. Lower scores are indicative of a worse nutritional status. The sum of its scores enables the following classification: from 0

to 7 presents malnutrition; from 8 to 11 presents having the risk of malnutrition; from 12 to 14 presents normal nutritional status[9].

*Hearing and visual function* Hearing function were evaluated through talking to the individuals and wearing hearing-aid was allowed. Hearing and visual functions were categorized into three groups, namely, severe or moderate impairment, mild impairment and intact.

*Cognition* The cognitive function was measured by the Cognitive Function Rating Scale (Shanghai Version). This scale is widely used in Shanghai for rating the care-level of the elderly. It composes of four categories including short-term memory, procedural memory, orientation function, and judgment function. The score ranges from 0 to 40 and a higher score indicates worse cognitive function. As a severity measure, the scale is scored from 0-1(intact cognition), 2-11(mild cognition decline), 12-25(moderate cognition decline) and 26 and over (severe cognitive decline). Its interrater reliability (0.896) was assessed using a sample of 30 individuals and its test-retest coefficient of reliability ( $r = 0.918$ ) was calculated for a time interval of two weeks and value of Cronbach's  $\alpha$  was 0.911.

### *Sociodemographic and clinical characteristics*

*Baseline sociodemographic variables* were collected including age, gender, education, marital status, economy, and living condition. Age was a continuous variable. Categorized variables were divided into groups, including education (<5 years, 6-11 years, >12 years); living condition (nursing homes and communities); economy (no vs yes; no indicating not specially funded by governments and yes indicating specially funded by governments); and marital status (partnered vs not partnered).

*Clinical characteristics*, namely, history of fall (yes vs no), auxiliary tools (yes vs no), self-rating health (very good, good, fair and poor), social support (sufficient material and emotional support, material support, emotional support, and insufficient material and emotional support), and social participation (active, regular, occasional and never) were collected. Five common diseases were collected from medical records (hypertension, stroke, coronary disease, diabetes, and cataract) as they were common diseases among the elderly in our research data. (Figure S1.)

### **Statistical analysis**

We used categorical patient characteristics such as the sex by ADL using the chi-square test, or, if expected cell counts were less than 5, continuity correction was applied. We used Wilcoxon tests to compare two groups on age, cognition, nutrition and pain scores as all tests of normality did not show normal distribution ( $p$  for Kolmogorov-Smirnov test < 0.05). These tests were all 2 sided.

To evaluate the association between IC and ADL, a multivariate analysis was fit with the use of dichotomous variables of ADL scale that was coded as '0' ( $76 \leq \text{ADL Scale score} \leq 100$ ) and '1' ( $0 \leq \text{ADL Scale score} \leq 75$ ) as the dependent variable[10]. The variables included in the multivariate analysis were variables with a  $p$ -value of less than 0.20[11, 12].

Missing values of variables (9 participants without marital status, 1 participant without living condition, and 13 without self-rating health) were imputed with the mode as they are category variables. Precisely, missing marriage status, living conditions, self-rating health self-rating health were replaced with not partnered, nursing home and fair, respectively. Statistical analysis was performed with free open-source R statistical software ([www.r-project.org](http://www.r-project.org)).

## Results

### *General characteristics*

A descriptive analysis of general characteristics, intrinsic capacity, clinical diagnosis, and health-related factors were shown in Table S1. The mean age was  $78.3 \pm 8.4$  years and 53.6% were female. Half of the individuals (50.0%) displayed mild to no impairment and 50.0% demonstrated moderate to severe impairment ADL. 53.3% of the participants were living in communities. The average scores of depression, cognition, and nutrition were 45.1, 8.5 and 11.3 respectively. More than half (51.5%) had mild vision impairment and 40.4% showed mild hearing impairment. Among the participants, 37.3% suffered hypertension, 20.3% suffered coronary disease, 21.5% suffered stroke, 10.0% suffered diabetes and 8.5% suffered cataract.

### *Logistic regression analysis*

Univariate analysis was performed by dividing participants into mild to no impairment (coded as No) and moderate to severe impairment (coded as Yes). Differences were shown in Table 1. IC domains of cognition, nutrition, depression and sensory function were significantly associated with ADL. Multivariate analysis showed that cognition, nutrition, and vision were significantly related to ADL. (Table 2)

Table 1  
Univariate regression analysis (N = 2016).

Variables	Categories	ADL		p value
		No (N = 1008)	Yes (N = 1008)	
Demographic Characteristics				
Age, y, Median[IQR]	-	80 [72, 84]	80 [73, 85]	0.00**
Sex, No. (%)	Male	478 (47.4)	458 (45.4)	0.40
	Female	530 (52.6)	550 (54.6)	
Education, y	<-5 years	581 (60.0)	576 (60.0)	0.61
	6–8 years	260 (30.0)	249 (20.0)	
	> 8 years	167 (20.0)	183 (20.0)	
Marriage Status, No. (%)	Partnered	952 (94.4)	983 (95.5)	0.00**
	Not Partnered	56 (5.6)	25 (2.5)	
Economy, No. (%)	No	923 (91.6)	952 (94.4)	0.01*
	Yes	85 (8.4)	56 (5.6)	
Living Condition, No. (%)	Community-dwelling elders	455 (45.1)	620 (61.5)	0.00**
	Nursing home elders	553 (54.9)	388 (38.5)	
Intrinsic Capacity				
Depression, Median [IQR]	-	3 [0, 6]	5 [1, 9]	0.00**
Cognition, Median [IQR]	-	1 [0, 6]	11 [9, 12]	0.00**
Nutrition, Median [IQR]	-	13 [11, 14]	11 [9, 12]	0.00**
Visual function, No. (%)	Moderate or severe	174 (17.3)	323 (36.0)	0.00*
	Mild	529 (52.5)	510 (50.6)	
	Intact	305 (30.3)	135 (13.4)	
Hearing, No. (%)	Moderate/severe	132 (13.1)	273 (27.1)	0.00**
	Mild	353 (35.0)	461 (45.7)	
	intact	523 (51.9)	274 (27.2)	
Clinical diagnosis				
Hypertension, No. (%)	No	636 (63.1)	629 (62.4)	0.78
**p < 0.01; *p < 0.05				

Variables	Categories	ADL		p value
	Yes	372 (36.9)	379 (37.6)	
Stroke, No. (%)	No	884 (87.7)	722 (71.6)	0.00**
	Yes	124 (12.3)	286 (28.4)	
Coronary disease, No. (%)	No	796 (79.0)	786 (78.0)	0.63
	Yes	212 (21.0)	222 (22.0)	
Diabetes, No. (%)	No	917 (91.0)	897 (89.0)	0.16
	Yes	91 (9.0)	111 (11.0)	
Cataract, No. (%)	No	919 (91.2)	926 (91.9)	0.63
	Yes	89 (8.8)	82 (8.1)	
Health-related factors				
Self-rating health, No. (%)	Very good	13 (1.3)	8 (0.8)	0.00**
	Good	295 (29.3)	133 (13.2)	
	Fair	488 (48.4)	390 (38.7)	
	Poor	212 (21.0)	477 (47.3)	
History of fall, No. (%)	No	800 (79.4)	674 (66.9)	0.00**
	Yes	208 (20.6)	334 (33.1)	
Auxiliary tools, No. (%)	No	645 (64.0)	288 (28.6)	0.00**
	Yes	363 (36.0)	720 (71.4)	
Social support, No. (%)	Both Sufficient	701 (69.5)	626 (62.1)	0.00**
	Only material	104 (10.3)	119 (11.8)	
	Only emotional	64 (6.3)	74 (7.3)	
	Both Insufficient	139 (13.8)	189 (18.8)	
Social participation, No. (%)	Active	166 (16.5)	37 (3.7)	0.00**
	Regular	138 (13.7)	31 (3.1)	
	Occasional	373 (37.0)	215 (21.3)	
	Never	331 (32.8)	725 (71.9)	
Pain, Median[IQR]	-	0 [0, 3]	0 [0, 4]	0.30
**p < 0.01; *p < 0.05				

Table 2  
Multivariate logistic regression analysis (N = 2016).

	Variables	Categories	OR (95% CI)	
			Mod 1	Mod 2
IC domains	Depression	(ref.1-unit increase)	1.05 (1.02–1.07)*	0.99 (0.96–1.01)
	Cognition	(ref.1-unit increase)	1.06 (1.05–1.08)*	1.07 (1.05–1.09)*
	Nutrition	(ref.1-unit increase)	0.74 (0.70–0.78)*	0.77 (0.73–0.82)*
	Vision	Intact (ref. severe)	0.63 (0.45–0.89)*	0.65 (0.44–0.95)*
	Hearing	Intact (ref. severe)	0.66 (0.47–0.92)*	0.79 (0.54–1.15)
*p < 0.05.				
Mod1: Adjustment for age, marriage, economic status, living condition.				
Mod2: Adjustment for age, marriage, economic status, living condition, mobility, self-rating health, history of fall, auxiliary tools, social support, social participation, stroke, diabetes.				

*The association between IC and ADL among community-dwelling elders*

As to participants living in the communities, the result showed that IC domains of depression, cognition, nutrition, and hearing were significantly related to ADL after adjustment for demographic characteristics. (Table 3)

Table 3  
the association between IC and ADL in different living conditions (N = 2016).

Variables	Categories	Community-dwelling elders	Nursing home elders
Depression	(ref.1-unit increase)	1.11 (1.07–1.14)*	1.01 (0.97–1.05)
Cognition	(ref.1-unit increase)	1.05 (1.02–1.07)*	1.08 (1.06–1.10)*
Nutrition	(ref.1-unit increase)	0.86 (0.80–0.93)*	0.58 (0.52–0.64)*
Vision	Intact (ref. vision loss)	0.77 (0.46–1.30)	0.54 (0.33–0.91)*
Hearing	Intact (ref. vision loss)	0.57 (0.34–0.95)*	0.86 (0.53–1.4)
*p < 0.05. Adjustment for age, marriage, economic status, living condition.			

*The association between IC and ADL among nursing home elders*

As to participants living in nursing homes, the result showed that IC domains of cognition, nutrition, and vision were significantly related to ADL when adjusted for confounders. (Table 3)

## Discussion

The innovative model recently proposed WHO has shifted 'healthy ageing' from disease-centered to function-centered paradigms. Functional ability is determined by the IC and the environment and interaction between both[5]. Overall, our study suggested that depression, cognition, nutrition, and sensory function were significantly associated with functional ability. However, the association between sensory function and ADL was not stable among Chinese people. Some studies from European and American countries have suggested a strong association between vision and functional ability among the elderly. A study exploring the association between sensory function and ADL and instrumental activities of daily living revealed the strong relationship between visual function between ADL whereas the effect of hearing on ADL score was not[13]. The association between hearing and functional status was controversial, but it was suggested the synergistic effect of vision and hearing function on functional status[13–15]. Consistent with the previous study, a vision was associated with reduced functioning as measured by ADL but the hearing was not when adjusting diseases and health-related factors. The ADL measures more global functioning in activities that are part of everyday living, such as walking across a small room, toileting, and getting from a bed to a chair. Hearing loss might be not likely to influence the implementation of these tasks[16].

Our study concluded that, as for community-dwelling elders, depression was significantly associated with ADL whereas as for nursing home elders, this association disappeared. This might due to depression differences in communities and nursing homes. Generally, elderly people in nursing homes were more likely to experience depression than community-dwelling elders[17, 18]. However, one study from Korea comparing the extent of depression in the nursing home and community-dwelling elderly people, the result showed that community-dwelling elderly people had higher odds of depression than the elderly in the community[19]. In China, the increasing life expectancy and employment of women, drop in birth rate and other changes have resulted in the rise in the number of elderly people living alone (they are called 'empty-nest elderly'), and they are more likely to suffer a high level of loneliness[20]. This implies that community living is sometimes accompanied by a lack of suitable friends or neighbors. On the contrary, nursing home residents have access to medical services and a whole spectrum of services to support daily living.

It was noteworthy that the association between nutrition and ADL was more obvious among the nursing home elderly (OR = 0.85) than that among community-dwelling elders (OR = 0.58). The prior study involving about 3,000 population examined the different nutrition status among older people living in communities and nursing home environments, result showing that nursing home people suffered worst nutritional state than community-dwelling groups[21]. One study from China[22] estimated that the prevalence of undernutrition in the nursing home was 16.1% and the risk of undernutrition was 43.68%. Another study from France[23] showed that the prevalence of undernutrition was 19.1, with a higher rate in long-term care (48.0%) than in nursing homes (14.5%). In general, undernutrition in nursing homes is prevalent among the elderly than in communities in China and has a strong association with functional ability.

## Limitations

This study has several limitations. Firstly, mobility, one of IC domains, was not able to be included in this study because of our data limitation. Moreover, we were not able to study the association between IC and instrumental activities of daily living that might be more sensitive to early functional decline. Secondly, some measurements of five IC domains were not identical to those proposed by WHO. However, WHO advocates the instruments used to measure those domains should be tailored to specific levels of IC[5]. Thirdly, this study was cross-sectional, further research is needed to examine IC's longitudinal association with disability in China. Fourthly, there is research studying the mechanism behind IC, but our study did not include biomarkers as covariates to observe its role on ADL. Identifying biomarkers that strongly associate with IC could help to dip into the mechanism of how IC influences functional ability and thus slow down the evolution of age-related functional decline.

## Conclusions

The IC as a whole definition comprising five domains, each domain in the Chinese was associated with ADL. However, the magnitude of the contribution of each IC domain to ADL is partly influenced by living conditions. The lower nutrition was a significant factor of ADL nursing home elders whereas depression was an important factor of community dwellers.

## Additional File

**Additional file: Table S1.** Demographic Characteristic of the Study Population. Figure S1. Figure S1. Prevalence of common diseases among the elderly in China.

## Abbreviations

IC: Intrinsic capacity; ADL: Activities of daily living; LCDA: Long-term Care Demand Assessment.

## Declarations

### Ethics approval and consent to participate

All participants gave their written informed consent. This study was approved by the Central South University Ethics Committee (approval number: 2018011).

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author (Hui Feng) on a reasonable request.

### **Competing interests**

The authors declare that they have no competing interests.

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### **Authors' contributions**

Thanks for all the contributions of the authors. FH conceived and designed the study, and supervised the data analysis. HHY was in charge of collecting the data. HMY wrote the paper. SXH helped with revising the manuscript. All authors have given final approval of the version to be published.

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## Supplementary Files

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- [TableS1FigureS1.docx](#)