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The prominent effect of physical activity on independent living ability among community-dwelling elderly in urban areas of China: a population-based study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023543
Article Type:	Research
Date Submitted by the Author:	11-Apr-2018
Complete List of Authors:	Wang, Bowen; China Medical University, Social Medicine, School of Public Health Wu, Yijiao Zhang, Tianjiao; China Medical University, Social Medicine, School of Public Health Han, Jinsong; China Medical University, Social Medicine, School of Public Health Yu, Lianzheng; Liaoning Provincial Center for Disease Control and Prevention, Shenyang, PR China., Department of Noncommunicable Chronic Disease Prevention Sun, Wei; China Medical University, Social Medicine, School of Public Health
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

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2 **The prominent effect of physical activity on independent living ability among**
3
4 **community-dwelling elderly in urban areas of China: a population-based study**

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ABSTRACT

Objective Independent living ability of the elderly is crucial to improve the quality of life and reduce the social burden; however, its assessment performed in China lacks standardization and risk factors, especially behavioral and social-psychological factors, which could be improved through health education. This study aimed to assess the independent living ability of community-dwelling elderly in urban areas of China and to clarify its association with behavioral and social-psychological factors.

Design A population-based study using random cluster sampling method was performed in 2 core cities in Liaoning Province during March-November 2012.

Study population A total of 3686 individuals who were ≥ 65 years old, had no dementia and cognitive defects, had lived in the sampled communities for ≥ 5 years, and could take part in the study were enrolled.

Main outcome measures Interviews were conducted to collect information of independent living ability, indicated by the instrumental activity of daily living (IADL), behavioral factors, social-psychological factors, and confounders (demographic characteristics and health status). The mini-mental state examination was used to screen for cognitive defects.

Results The independence rate was 46.3% in males and 41.1% in females. Structural equation modeling analysis showed that physical activity, drawn from taking a walk and doing exercise, had the strongest association with the IADL in both males (-0.34) and females (-0.33). Falling in the last year and worrying about falling were also significantly associated with IADL. The effects of alcohol consumption, feeling lonely, and participating in entertainment were significant in males.

Conclusion The independent living ability of the elderly in urban areas in China was at a low level. Physical activity had a prominent role; whereas the role of social-psychological factors only existed in males. Gender-specific health care and education on avoiding sedentary life should be advocated for the elderly to maintain/improve their independent living ability.

Strengths and limitations of this study

- ▶ This study used the Lawton IADL scale, which has been used worldwide to indicate independent living ability of the elderly. The effects of behavioral and social-psychological factors that could be improved through health education in daily life were assessed among a Chinese population with adjustment for demographic characteristics and health status.
- ▶ Information bias was excluded because the cognitive function of the elderly without dementia was further screened using the mini-mental state examination.
- ▶ Quantitative assessment through scoring measured factors according to the OR values was conducted and the effects on IADL were confirmed by structural equation modeling analysis.

INTRODUCTION

A significant change in the age structure of the world's population has resulted from population aging,¹ and has become a global issue in the 21st century.^{2 3} China is a nation with the largest aging population, which accounts for one-fifth of the total elderly population worldwide.⁴ Indeed, it has been estimated that China will experience the most rapid rate of aging in the world over the next 2–3 decades.¹ Thus, how to cope with problems caused by population aging has become particularly important for the development of China.

For the elderly, independence in daily life reduces nursing demands, decreases the consumption of medical resources, and improves the quality of life. Even if the loss of independent living ability is inevitable for the elderly, maintaining and/or improving this ability, even for short time, can postpone the onset of dependency and reduce the enormous social burden. Thus, focusing on the independent living ability among the elderly prior to death or becoming ill is important.

Previous studies involving the independent living ability of the elderly have been conducted in developed countries.⁵⁻⁹ The factors associated with the independent living ability of the elderly have been shown to be demographic characteristics (age, gender, ethnicity, marital status, education, and living arrangement), health status (chronic disease, visual ability, and hearing ability), behavior factors (smoking, alcohol consumption, taking a walk, doing exercise, and falling risk), and social-psychological factors (social integration, depressive symptoms, and social activity). Related studies have also been conducted in China;¹⁰⁻¹² however, various scales were used to indicate independence. As a result, the rate of dependency ranged from 7.9%-53.9%. The risk factors were limited to demographic characteristics and chronic disease. Consideration of behavioral and social-psychological factors that could be improved through health education in daily life was lacking. In addition, cognitive function screening was rarely considered in international and domestic studies, which was insufficient with respect to excluding information bias, especially for the aged population.

The purpose of this study was to conduct a population-based study to assess the independent living ability among the elderly without cognitive defects in China, and to clarify the effects of behavioral and social-psychological factors with adjustment for demographic characteristics and health status. As a first attempt, we initially focused our attention on the elderly in urban areas. We believe our findings will provide evidence for the healthcare system to properly cope with population aging.

METHODS

Study area and population

According to the China Yearbook, the income level in Liaoning Province is similar to the national average. Shenyang city and Anshan city are the core cities in Liaoning Province and represent the urban area according to the Liaoning Provincial Yearbook.¹³ Two communities in each city were randomly selected and people who were ≥ 65 years of age, had no dementia, lived in the local area for ≥ 5 years, and volunteered to take part in this study comprised the study population (a total of 4701 individuals). The interview was conducted between March and November 2012. We received effective responses from 4057 participants and the effective response rate was 86.3%. After screening for cognitive function with the mini-mental state examination, 3686 individuals without cognitive defects were enrolled as the subjects in the current study.

Measurement of independent living ability

The Lawton instrumental activities of daily living (IADL) scale has been widely used to assess independent living ability of the elderly.¹⁴ The IADL scale has eight items assessing the ability to use the telephone, shop for daily necessities, prepare meals, handle finances, do housework, take medications, do laundry, and use public transportation. Responses to each item are coded as 1 (completely able), 2 (have some difficulty), 3 (need help), or 4 (unable). The total score ranges from 8-32. The higher the score, the worse the independence. Independence is defined only if the total score is 8.

Measurements of behavioral factors, social–psychological factors, and confounders

Behavioral factors included the following six items: (1) smoking; (2) alcohol consumption; (3) taking a walk; (4) doing exercise; (5) regular diet; and (6) falling in the last year. Smoking was measured with answers of “Yes,” “Had ever,” or “Never.” Alcohol consumption was categorized as “Yes” or “No.” Taking a walk and doing exercise were divided into four groups on the basis of frequency: almost none; 1-2 times/week; 3-4 times/week; and almost every day.¹³ Regular diet and falling in the last year were defined as “Yes” or “No.”

Social-psychological factors consisted of the following five items: (1) feeling lonely; (2) participating in entertainment; (3) watching television often; (4) worrying about falling; and (5) filial piety. Feeling lonely was assessed according to an individual’s perception and was categorized as “Yes,” “Not clear,” or “No.” Information on participating in entertainment and watching

1 television often was examined by asking “Do you often hang out and play cards, chess, mahjong, or
2 some other entertainment?”¹³ and “Do you often watch television?”. Worrying about falling was
3 defined as “Yes” or “No.” Filial piety is a prime virtue in Confucianism and advocated by Chinese
4 traditional culture. The filial piety of children is expected to affect the health of the elderly. Thus,
5 filial piety was included and assessed by asking “How do you feel about your children’s filial duty
6 to you?”. The responses “So so” and “Bad” accounted for 8.8% and 0.4% of responses, respectively.
7 These responses were combined into one group.
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Confounders included factors of demographic characteristics and health status. Demographic characteristics included age, gender, ethnicity, marital status, living arrangement, pension, and health insurance. For marital status, the responses were “Single,” “Divorced,” and “Separation” were combined with “Widow” as the “Other” group because of the low response rate (<5%). Health status included chronic disease, visual ability,⁸ hearing ability,⁸ daily sleep time, sleep quality, and chewing ability.¹⁵ Chronic diseases were categorized as “Present” if any diseases, such as hypertension, cardiovascular disease, diabetes, stroke, liver cirrhosis, emphysema, rheumatoid arthritis, and chronic renal insufficiency, had been diagnosed. For daily sleep time, the responses “<4 hours” (2.7%) and “>8 hours” (6.0%) were combined as one group. Sleep quality measured the difficulty in falling sleep or frequent awakening/dreaming.

Statistical analysis

Among all independent variables, the items which > 95% of the participants had the same response were excluded from the data analysis. In our study, 98.4% of males and 96.9% of females reported having health insurance and 95.9% of males reported Han ethnicity. Therefore, these items were not included in the data analysis.

The distribution of IADL (independence) among categorical variables was examined by the chi-square test. The odds ratio (OR) was calculated in comparison to the basic group. Then, the quantitative values of these variables were scored according to the OR values. Structural equation modeling (SEM) was used to identify the effect of factors measured on IADL score.

The agreement between categorical variables was evaluated with the Kappa test. If the Kappa value was more than 0.50, these variables were considered in agreement. As for quantitative values, Pearson correlation was used to identify the co-line variables.

The missing data was not handled because the missing rate was less than 5%. SPSS for Windows (version 13.0) and AMOS (version 6.0) were used for all statistical analyses.

RESULTS

Among 3686 subjects, the independence in males and females was 46.3% and 41.1%, respectively. The results of univariate analysis of the IADL scale (independence) are shown in Table 1. Among the community-dwelling elderly in urban areas, the items significantly correlated with the IADL were smoking, taking a walk, doing exercise, regular diet, falling in the last year, worrying about falling, feeling lonely, participating in entertainment, watching TV often, and filial piety in both males and females. The distribution of IADL (independence) among demographic characteristics and health status is shown in Appendix A.

The average IADL scores were 11.27 ± 4.26 (mean \pm SD) in males and 12.05 ± 5.23 in females. The items were scored according to the OR values. In this study, the correlations between “taking a walk” and “doing exercise” were 0.6252 in males and 0.5746 in females. Therefore, a latent variable, “physical activity,” drawn from these two variables was used, which was the same as confounders of “marital status” and “living arrangement” (r : 0.8074 in males and 0.6443 in females). A latent variable (family status) was obtained. The scores are shown in Table 2. The scores of demographic characteristics and health status are shown in Appendix B.

SEM examinations for confirming the effects of behavioral and social-psychological factors were performed separately in males and females. The results are shown in Figures 1 and 2. SEM analysis revealed that the latent variable (physical activity) had the highest association with the IADL score in both males and females. The parameter estimate (B) was -0.34 in males and -0.33 in females. In males, the IADL score was associated with feeling lonely, worrying about falling, alcohol consumption, falling in the last year, and participating in entertainment, with adjustments for family status, age, chronic disease, chewing ability, daily sleep time, visual ability, and sleep quality. In females, the IADL score was associated with falling in the last year and worrying about falling, with adjustments for ethnicity, daily sleep time, family status, age, visual ability, chronic disease, pension, and hearing ability.

DISCUSSION

In this study, our sample size was sufficiently large and information bias was excluded because of dementia and cognitive function screening with the mini-mental state examination. All these facts increased the generalization of our conclusions. The prevalence of independence in daily living

1
2 ability among the elderly in urban areas was 43.5%. The independence in daily living ability was
3 significantly lower than the level (54.8%) observed in the elderly living in urban areas in Shanghai
4 (n=2944),¹⁶ even though the average age of our study population (73.2 years) was much younger
5 than the population in Shanghai (78.44 years). In addition, independent living ability in females
6 (41.1%) was lower than males (46.3%), which was consistent with the results of the urban elderly in
7 Suzhou;¹² however, the life expectancy of females (79.4) was longer than males (73.6) according to
8 the China Yearbook,¹⁷ thus suggesting that more attention should be paid to maintaining dependent
9 living for a longer time in elderly females. These findings indicated that the independent living
10 ability among the urban elderly in Liaoning province is still at a low level. Maintaining/improving
11 independent living ability of the elderly, especially females, is essential part of providing healthcare
12 for the aged population.

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22 With respect to the behavioral factors, physical activity was reported to not only maintain
23 physical health of the elderly, but also prevent elderly from acquiring mental diseases.¹⁸ In our
24 study, taking a walk and doing exercise were considered to measure physical activity among the
25 elderly; however, due to the high agreement between walking and doing exercise, previous studies
26 have usually selected one item to enter into the multiple model while assessing their effects. In this
27 study, the kappa value between taking a walk and doing exercise was also high (0.546). Of note, we
28 are not satisfied with this type of adjustment because taking a walk and doing exercise require
29 different intensities of activity. This kind of assessment was expected to weaken the effect of
30 physical activity. Thus, we used the latent variable, physical activity, to represent the effects of both
31 taking a walk and doing exercise. As a result, physical activity was shown to have the strongest
32 association with IADL in both males and females. Although health status was reported to be crucial
33 for the quality of life of the elderly in our previous study¹³ and the presence of chronic disease was
34 well-documented as the basis of any disorder,^{19 20} the associations with the IADL score were
35 weaker than physical activity. Furthermore, we found that the more frequent the elderly performed
36 physical activity, the stronger the effect on the independent living ability. Our results revealed that
37 health education on avoiding sedentary life was effective and any type of activity should be
38 advocated for the independence of the elderly regardless of health status.

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53 With respect to behavioral factors, falling in the last year and worrying about falling were also
54 associated with independent living ability in both males and females. The experience of falling in
55 the last year indicated that muscle strength, coordination, balance, and flexibility had declined,²¹

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2 which tended to be a potential threat for fractures and becoming bedridden among the elderly.²²
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4 Indeed, worrying about falling will inevitably limit movement among the elderly. Correspondingly,
5 the effects on independent living ability were observed in both males and females. Thus, we should
6 pay more attention to the safety of daily routines. In addition, alcohol consumption was shown to be
7 significantly associated with IADL in males. Even if the elderly do not consume alcohol excessively
8 and measurement of alcohol consumption is inexact, the harmful influence on the IADL score was
9 shown. Therefore, guiding the elderly to avoid alcohol would contribute to independent living
10 ability.
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16 In comparison to behavioral factors, the effects of social-psychological factors on independent
17 living ability of the elderly were weaker with adjustment for demographic characteristics and health
18 status. A previous study reported that social participation enhanced the ability of the elderly to live
19 independently.²³ In this study, feeling lonely and participating in entertainment were shown to be
20 significantly associated with independent living ability, but only in males. This finding might be
21 caused by the Chinese traditional view “men go out to work and women stay at home.” Thus, going
22 out to enjoy an animated atmosphere and having more opportunities to participate in entertainment
23 seemed to be more effective in keeping males in good physical and mental health compared to
24 females, who are accustomed to being confined to home.
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33 There were some limitations in our study. First, the measurements of several assessed factors
34 were broad and simplistic, such as smoking and alcohol consumption. Second, even if our study
35 was a population-based study, it was limited by the cross-sectional design. Therefore, a prospective
36 study is needed to draw any causal conclusions.
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42 CONCLUSION

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44 Our results showed that independent living ability among the elderly in urban areas in China is at
45 a low level. Physical activity has a prominent role in maintaining and/or improving independent
46 living ability of the elderly, even if health status has a crucial effect. Social-psychological factors,
47 such as feeling lonely and participating in entertainment, could affect independent living ability
48 among elderly males. Our findings suggest that gender-specific healthcare should be adopted as part
49 of health promotion for the elderly. Physical activity of any type should be encouraged to maintain
50 and improve the independent living ability of the elderly.
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2 **Contributors:** WS designed the study and supervised the performance of study. BW and YW
3 collected the data, analyzed the data and wrote the manuscript. TZ and JH helped with cleaning the
4 data, giving advice on statistical analysis and revising the manuscript. LY coordinated data
5 collection. All authors have given final approval of the version to be published.
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11 **Funding:** This research was funded by the National Natural Science Foundation of China [grant
12 number: 81102193].
13
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15
16 **Disclaimer:** The funding agencies are not responsible for the opinions presented in the manuscript.
17 The funding bodies had no influence on the conduct of the study or the interpretation of the results.
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22 **Competing interest:** None declared.
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26 **Ethics approval:** The study protocol and informed consent form received ethics approval from the
27 Committee on Human Experimentation at the China Medical University. Written informed consent
28 concerning conduct of the survey was obtained from each participant.
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33 **Provenance and peer review:** Not commissioned; externally peer reviewed.
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37 **Data sharing statement:** No additional data sharing available.
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Table 1 Univariate analysis of IADL scale (independence) in relation to behavioral factors and social-psychological factors.

Variables	Males			Females		
	N	Independence (%)	OR(95%CI)	N	Independence (%)	OR(95%CI)
Total	1726	46.3		1960	41.1	
Behavioral factors						
Smoking						
Yes	548	40.9		177	32.2	
Had ever	478	30.8	0.64(0.50-0.83)	270	30.7	0.93(0.62-1.41)
Never	696	61.1	2.27(1.81-2.85)	1512	44.0	1.65(1.19-2.30)
Alcohol consumption						
Yes	750	46.0		242	36.0	
No	969	46.4	1.02(0.84-1.23)	1716	41.8	1.28(0.97-1.70)
Taking a walk						
Almost none	325	27.1		283	9.90	
1-2 times/week	385	28.1	1.05(0.75-1.46)	421	30.4	3.98(2.56-6.19)
3-4 times/week	460	58.0	3.73(2.74-5.06)	488	48.6	8.60(5.60-13.20)
Almost everyday	556	60.4	4.11(3.05-5.54)	768	53.6	10.54(6.96-15.96)
Doing exercise						
Almost none	470	25.7		460	16.5	
1-2 times/week	354	36.4	1.65(1.23-2.23)	465	34.8	2.70(1.98-3.69)
3-4 times/week	452	52.9	3.24(2.45-4.27)	483	43.3	3.85(2.84-5.23)
Almost everyday	450	68.9	6.39(4.79-8.51)	552	64.9	9.32(6.90-12.61)
Regular diet						
No	201	32.8		289	22.1	
Yes	1525	48.1	1.89(1.39-2.58)	1671	44.3	2.80(2.09-3.76)
Falling in the last year						
Yes	162	35.2		295	16.9	
No	1562	47.4	1.66(1.18-2.32)	1664	45.4	4.07(2.96-5.60)
Worrying about falling						
Yes	681	24.2		870	25.3	
No	1043	60.6	4.81(3.88-5.96)	1086	53.8	3.44(2.83-4.17)
Social-psychological factors						
Feeling lonely						
Yes	232	28.9		332	23.8	
Not clear	354	26.0	0.87(0.60-1.25)	385	23.1	0.96(0.68-1.36)
No	1124	55.9	3.12(2.29-4.24)	1228	51.3	3.37(2.56-4.45)
Participating in entertainment						
No	613	24.5		815	30.2	
Yes	1109	58.3	4.32(3.47-5.38)	1139	48.8	2.21(1.83-2.67)
Watching TV often						
No	218	26.1		283	22.6	
Yes	1507	49.2	2.73(1.99-3.76)	1674	44.1	2.70(2.01-3.63)
Filial piety						
So so/bad	176	21.0		165	20.0	
Good	625	40.6	2.57(1.73-3.82)	673	40.0	2.66(1.77-4.02)
Very good	907	55.7	4.72(3.21-6.94)	1108	45.3	3.31(2.22-4.94)

Note. OR: Odd ratio; 95%CI: 95% confidence interval.

Table 2. The scores of IADL and assessed factors according to their OR values.

Variables	Males		Females	
	N	Mean±SD	N	Mean±SD
Total	1726	11.27±4.26	1960	12.05±5.23
Behavioral factors				
Smoking	1722	1.41±0.72	1959	1.50±0.29
Alcohol consumption	1719	1.01±0.01	1958	1.25±0.09
Taking a walk	1726	2.74±1.44	1960	7.27±3.56
Doing exercise	1726	3.12±2.11	1960	4.45±3.21
Regular diet	1726	1.79±0.29	1960	2.54±0.64
Falling in the last year	1724	1.60±0.19	1959	3.61±1.10
Worrying about falling	1724	3.30±1.86	1956	2.35±1.21
Social-psychological factors				
Feeling lonely	1710	2.36±1.05	1945	2.49±1.16
Participating in entertainment	1722	3.14±1.59	1954	1.70±0.60
Watching TV often	1725	2.51±0.58	1957	2.46±0.60
Filial piety	1708	3.55±1.32	1946	2.89±0.65

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Figure 1. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in males.

Figure 2. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in females.

For peer review only

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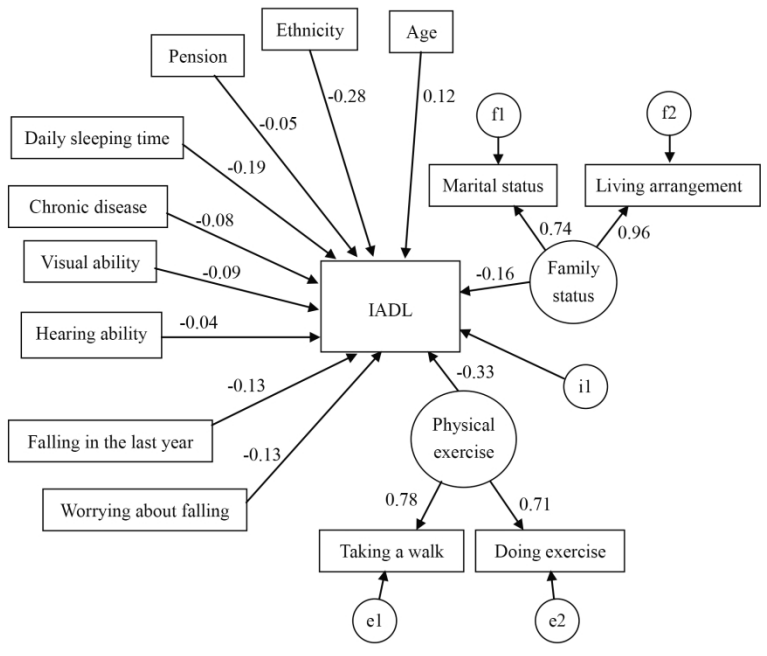


Figure 2. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in females.

199x150mm (300 x 300 DPI)

Appendix A. Distribution of IADL scale (independence) in demographic characteristics and health status.

Variables	Males			Females		
	N	Independence (%)	OR(95%CI)	N	Independence (%)	OR(95%CI)
Demographic characteristics						
Age						
75+	580	30.0		814	19.4	
65-74	1146	54.5	2.80(2.26-3.46)	1146	56.5	5.38(4.37-6.64)
Ethnicity						
Minority	-	-		269	15.2	
Han	-	-	-	1690	45.1	4.58(3.24-6.47)
Marital status						
Other	302	20.5		470	20.6	
Married/cohabitation	1423	51.8	4.16(3.09-5.60)	1490	47.5	3.48(2.72-4.45)
Living arrangement						
Living alone	184	21.7		227	30.8	
Living with spouse	1230	54.1	4.25(2.94-6.14)	1159	53.4	2.57(1.90-3.49)
Living with spouse and children	184	37.0	2.11(1.33-3.35)	327	26.9	0.83(0.57-1.20)
Living with children	126	19.8	0.89(0.51-1.56)	243	11.1	0.28(0.17-0.46)
Pension						
Haven't	116	36.2		188	16.0	
Have	1606	47.0	1.56(1.06-2.31)	1769	43.6	4.08(2.73-6.09)
Health status						
Chronic disease						
Present	1264	34.2		1529	31.9	
Not present	462	79.4	7.44(5.77-9.59)	431	73.5	5.93(4.67-7.54)
Visual ability						
Impaired	691	37.9		844	28.1	
Good	1030	51.8	1.76(1.45-2.15)	1112	50.9	2.66(2.19-3.21)
Hearing ability						
Impaired	763	29.4		853	23.2	
Good	957	59.7	3.56(2.91-4.36)	1102	54.9	4.03(3.30-4.91)
Daily sleeping time						
<4/>8 hours	110	28.2		210	11.4	
4-6 hours	906	42.4	1.88(1.21-2.90)	977	40.0	5.17(3.32-8.06)
6-8 hours	710	54.1	3.00(1.93-4.67)	769	50.5	7.89(5.04-12.35)
Sleeping quality						
Bad	765	30.2		968	27.4	
Good	961	59.1	3.34(2.73-4.08)	992	54.4	3.17(2.63-3.83)
Chewing ability						
Bad	426	20.7		651	15.5	
Middle	903	44.9	3.12(2.39-4.09)	989	46.0	4.64(3.63-5.94)
Good	396	77.3	13.06(9.37-18.20)	317	78.2	19.60(13.92-27.52)

Note. OR: Odd ratio; 95%CI: 95% confidence interval.

Appendix B. The scores of demographic characteristics and health status according to their OR values.

Variables	Males		Females	
	N	Mean±SD	N	Mean±SD
Demographic characteristics				
Age	1726	72.87±5.84	1960	73.55±5.82
Ethnicity	--	--	1959	4.09±1.23
Marital status	1725	3.61±1.20	1960	2.89±1.06
Living arrangement	1724	3.43±1.33	1956	1.81±0.93
Pension	1722	1.53±0.14	1957	3.78±0.91
Health status				
Chronic disease	1726	2.72±2.85	1960	2.08±2.04
Visual ability	1721	1.46±0.37	1956	1.94±0.82
Hearing ability	1720	2.42±1.27	1955	2.71±1.50
Daily sleeping time	1726	2.28±0.64	1956	5.79±2.10
Sleeping quality	1726	2.30±1.16	1960	2.10±1.09
Chewing ability	1725	4.88±4.55	1957	5.85±6.25

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	In my manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Page 1 in title and Page 2, Line 8-9
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, Line 13-25
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4, Line 2-25
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4, Line 26-31
Methods			
Study design	4	Present key elements of study design early in the paper	Page 5, Line 13 to Page 6, Line 17
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5, Line 4-7 and Line 9-10
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5, Line 7-9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 5, Line 13 to Page 6, Line 17
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 5, Line 13 to Page 6, Line 17
Bias	9	Describe any efforts to address potential sources of bias	Page 5, Line 7 and Line 10-12
Study size	10	Explain how the study size was arrived at	We had introduced the prevalence of dependency (7.9%-53.9%) in the introduction section. According to the formula $N=100*(1-p)/p$, sample size of 1166 is large enough. In our study, totally we interviewed 4701 individuals, which is much more than the size calculated. Thus, we did not explain a lot about it.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 5, Line 17-20 and Page 6, Line 24-25
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 6, Line 23-26
		(b) Describe any methods used to examine subgroups and interactions	Page 6, Line 27-29
		(c) Explain how missing data were addressed	Page 6, Line 30
		(d) If applicable, describe analytical methods taking account of sampling strategy	None
		(e) Describe any sensitivity analyses	None

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60**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 5, Line 8-12 and Page 7, Line 3
		(b) Give reasons for non-participation at each stage	None
		(c) Consider use of a flow diagram	None
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and Appendix A
		(b) Indicate number of participants with missing data for each variable of interest	Tables 1 and 2 showed the actual number and the total number.
Outcome data	15*	Report numbers of outcome events or summary measures	None
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 7, Line 3-26; Tables 1 and 2, and Appendix A and B.
		(b) Report category boundaries when continuous variables were categorized	None
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 7, Line 11-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 7, Line 31 to Page 9, Line 17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 9, Line 18-21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9, Line 24-30
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 7, Line 29-31
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 10, Line 6-7

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at

1
2 <http://www.annals.org/>, and *Epidemiology* at <http://www.epidem.com/>). Information on the STROBE Initiative is
3 available at www.strobe-statement.org.
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BMJ Open

The prominent effect of physical activity on independent living ability among community-dwelling elderly in urban areas of Liaoning Province in China: a population-based study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023543.R1
Article Type:	Original research
Date Submitted by the Author:	11-Jan-2019
Complete List of Authors:	Wang, Bowen; China Medical University, Social Medicine, School of Public Health Wu, Yijiao Zhang, Tianjiao; China Medical University, Social Medicine, School of Public Health Han, Jinsong; China Medical University, Social Medicine, School of Public Health Yu, Lianzheng; Liaoning Provincial Center for Disease Control and Prevention, Shenyang, PR China., Department of Noncommunicable Chronic Disease Prevention Sun, Wei; China Medical University, Social Medicine, School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

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3 **The prominent effect of physical activity on independent living ability among**
4 **community-dwelling elderly in urban areas of Liaoning Province in China: a**
5
6 **population-based study**
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ABSTRACT

Objective Independent living ability is crucial for the elderly; however, its assessment performed in China employs various scales and lacks risk factors, especially behavioral and social-psychological factors, which could be improved through health education. This study aimed to assess the independent living ability of community-dwelling elderly in urban areas of China and to identify its association with behavioral and social-psychological factors.

Design A population-based study using random cluster sampling method was performed in two core cities in Liaoning Province during March-November 2012.

Study population A total of 3686 individuals who were ≥ 65 years old, had no dementia and cognitive impairment, had lived in the sampled communities for ≥ 5 years, and could take part in the study were enrolled.

Main outcome measures Interviews were conducted to collect information of independent living ability, indicated by the instrumental activity of daily living (IADL), behavioral factors, social-psychological factors, and confounders (demographic characteristics and health status). The mini-mental state examination was used to screen for cognitive impairment.

Results The independence rate was 46.3% in males and 41.1% in females. Structural equation modeling analysis showed that physical activity, drawn from taking a walk and doing exercise, had the strongest association with the IADL in both males (-0.34) and females (-0.33). Falling in the last year and worrying about falling were also significantly associated with IADL. The effects of alcohol consumption, feeling lonely, and participating in entertainment were significant in males.

Conclusion The independent living ability of the elderly in urban areas in Liaoning Province in China was at a low level. Physical activity was one of the important roles in both males and females; whereas the role of social-psychological factors only existed in males. Gender-specific health care and education to avoid sedentary life should be advocated for the elderly to maintain/improve their independent living ability.

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Strengths and limitations of this study

- ▶ The Lawton IADL scale was applied in this study, which has been used worldwide to indicate independent living ability of the elderly.
- ▶ The effects of behavioral and social-psychological factors that could be improved through health education in daily life were assessed among a Chinese population with adjustment for demographic characteristics and health status, whereas the measurements of smoking and alcohol consumption were broad and simplistic as the first attempt.
- ▶ Information bias was controlled as sufficient as possible because the cognitive function of the elderly without dementia was further screened using the mini-mental state examination.
- ▶ Quantitative assessment through scoring measured factors according to the OR values was conducted and the effects on IADL were confirmed by structural equation modeling analysis.

INTRODUCTION

A significant change in the age structure of the world's population has resulted from population aging,¹ and has become a global issue in the 21st century.^{2,3} China is a nation with the largest aging population, which accounts for one-fifth of the total elderly population worldwide.⁴ Indeed, it has been estimated that China will experience the most rapid rate of aging in the world over the next 2–3 decades.¹ Thus, how to cope with problems caused by population aging has become particularly important for the development of China.

For the elderly, independence in daily life reduces nursing demands, decreases the consumption of medical resources, and improves the quality of life. Even if the loss of independent living ability is inevitable for the elderly, maintaining and/or improving this ability, even for short time, can postpone the onset of dependency and reduce the enormous social burden. Thus, focusing on the independent living ability among the elderly prior to death or becoming ill is important.

Previous studies involving the independent living ability of the elderly have been conducted in developed countries.⁵⁻⁹ The factors associated with the independent living ability of the elderly have been shown to be demographic characteristics (age, gender, ethnicity, marital status, education, and living arrangement), health status (chronic disease, visual ability, and hearing ability), behavior factors (smoking, alcohol consumption, taking a walk, doing exercise, and falling risk), and social-psychological factors (social integration, depressive symptoms, and social activity). Related studies have also been conducted in China;¹⁰⁻¹² however, various scales were used to indicate independence. As a result, the rate of dependency ranged from 7.9%-53.9%. The risk factors were limited to demographic characteristics and chronic disease. As for behavioral and social-psychological factors, health education interventions on smoking, respiratory function exercise, diabetes-related activity, anxiety, family support and so on, had already been identified to be able to improve health status of the elderly.¹³⁻¹⁵ Thus, these factors should also be studied from the perspective of independent living ability. Unfortunately, those educational risk factors in daily life were not considered in China. In addition, cognitive function screening was rarely considered in international and domestic studies, which was insufficient with respect to excluding information bias, especially for the aged population.

The purpose of this study was to conduct a population-based study to assess the independent living ability among the elderly without cognitive impairment in China, and to clarify the effects of behavioral and social-psychological factors with adjustment for demographic characteristics and

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2 health status. As a first attempt, we initially focused our attention on the elderly in urban areas. We
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4 believe our findings will provide help for the healthcare system to properly cope with population
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10 **METHODS**

11 **Study area and population**

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14 According to the China Yearbook, the income level in Liaoning Province is similar to the
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16 national average. Shenyang city and Anshan city are the core cities in Liaoning Province and
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18 represent the urban area according to the Liaoning Provincial Yearbook. Two districts in each city
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20 were randomly sampled and one community in each sampled district was randomly selected. People
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22 who were ≥ 65 years of age, had never be diagnosed as dementia by doctors, lived in the local area
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24 for ≥ 5 years, and volunteered to take part in this study comprised the study population (a total of
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26 4701 individuals). Investigators were recruited from graduate students who majored in medical
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28 epidemiology and trained for two weeks with the purpose to control respondent bias. Face-to-face
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30 interview was conducted between March and November 2012. 4057 participants completed 80%
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32 and more of interview and were identified as effective responses. The effective response rate was
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34 86.3%. Cognitive function was further screened with the mini-mental state examination (MMSE).
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36 Cognitive impairment was identified with consideration on education as: illiterate ≤ 17 , elementary
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38 ≤ 20 , middle/high school ≤ 22 , junior college and over ≤ 23 . In the current study, 3686
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40 individuals without cognitive impairment were enrolled as the subjects.

41 **Measurement of independent living ability**

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43 The Lawton instrumental activities of daily living (IADL) scale has been widely used to assess
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45 independent living ability of the elderly.¹⁶ It has been validated among Chinese elderly.¹⁷ The
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47 IADL scale has eight items assessing the ability to use the telephone, shop for daily necessities,
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49 prepare meals, handle finances, do housework, take medications, do laundry, and use public
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51 transportation. Responses to each item are coded as 1 (completely able), 2 (have some difficulty), 3
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53 (need help), or 4 (unable). The total score ranges from 8-32. The higher the score, the worse the
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55 independence. Independence is defined only if the total score is 8.

56 **Measurements of behavioral factors, social–psychological factors, and confounders**

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58 Behavioral factors included the following six items: (1) smoking; (2) alcohol consumption; (3)
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60 taking a walk; (4) doing exercise; (5) regular diet; and (6) falling in the last year. Smoking was

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3 measured with answers of “Yes,” “Had ever,” or “Never.” Alcohol consumption was examined by
4 asking “Do you drink regularly (twice or more a week for more than a year)?”. The responses were
5 categorized as “Yes” or “No.” Taking a walk and doing exercise (including Tai chi chuan, jogging,
6 running, riding a bike, swimming, and playing shuttlecock, table tennis and so on), were divided
7 into four groups on the basis of frequency: almost none; 1-2 times/week; 3-4 times/week; and
8 almost every day.¹⁸ Regular diet was measured by asking “Do you have breakfast, lunch and dinner
9 on time?”. Falling in the last year was defined as “Yes” or “No.”

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16 Social-psychological factors consisted of the following five items: (1) feeling lonely; (2)
17 participating in entertainment; (3) watching television often; (4) worrying about falling; and (5)
18 filial piety. Feeling lonely was assessed according to an individual’s perception and was categorized
19 as “Yes,” “Not clear,” or “No.” Information on participating in entertainment and watching
20 television often was examined by asking “Do you always hang out and play cards, chess, mahjong,
21 or some other entertainment?”¹⁸ and “Do you watch television almost every day?”. Worrying about
22 falling was defined as “Yes” or “No.” Filial piety is a prime virtue in Confucianism and advocated
23 by Chinese traditional culture. The filial piety of children is expected to affect the health of the
24 elderly. Thus, filial piety was included and assessed by asking “How do you feel about your
25 children’s filial duty to you?”. The responses “So so” and “Bad” accounted for 8.8% and 0.4% of
26 responses, respectively. These responses were combined into one group.

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Patient and public involvement

Only community residents were involved as participants in this study. They received the written information about the conduct of the survey. However, they were not involved in the development

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2 of the research question and outcome measures, the recruitment of subjects and the undertaking of
3 the study. After signing an informed consent, they were assessed for eligibility and data collection
4 was conducted.
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8 **Statistical analysis**

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10 Among all independent variables, health insurance in both males and females and ethnicity in
11 males were not considered in the data analysis as > 95% of the participants had the same response.

12
13 The distribution of IADL (independence) among categorical variables was examined by the
14 chi-square test. The odds ratio (OR) was calculated in comparison to the baseline. Then, the
15 quantitative values of these variables were scored according to the OR values. The baseline was
16 scored as 1 and the other groups were scored as the corresponding OR values. Structural equation
17 modeling (SEM) was used to confirm the effect of factors measured on IADL score. Maximum
18 likelihood estimates was selected to fit SEM. While performing SEM analysis, variables with $p >$
19 0.05 were eliminated, in the sequence of p value, one at a time. When a variable was eliminated, if
20 the goodness of fit became worse, this variable would remain in the model. In this study, no
21 variable was found to decrease the goodness of fit during elimination. The goodness of fit of SEM
22 model was indicated by GFI, CFI/TLI and RMSEA. The proposed values indicating high goodness
23 of fit was $GFI > 0.8$, $CFI/TLI > 0.9$, and $RMSEA < 0.8$.

24
25 The agreement between categorical variables was evaluated with the Kappa test. If the Kappa
26 value was more than 0.50, these variables were considered in agreement. As for quantitative values,
27 Pearson correlation was used to identify the collinear variables.
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31 The missing data was not handled because the missing rate was less than 5%. SPSS for Windows
32 (version 13.0) and AMOS (version 6.0) were used for all statistical analyses.
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35 **RESULTS**

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37 Among 3686 subjects, the independence in males and females was 46.3% and 41.1%,
38 respectively. Totally, 43.5% of individuals were independent. In comparison to the results (54.8%)
39 obtained from urban areas in Shanghai ($n=2944$),¹⁷ the level of independence was significantly
40 lower ($p < 0.01$). The results of univariate analysis of the IADL scale (independence) are shown in
41 Table 1. Among the community-dwelling elderly in urban areas, the factors that were significantly
42 correlated with the IADL included smoking, taking a walk, doing exercise, regular diet, falling in
43 the last year, worrying about falling, feeling lonely, participating in entertainment, watching TV
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2 often, and filial piety in both males and females. The distribution of IADL (independence) among
3 demographic characteristics and health status is shown in Appendix A.
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6 The average IADL scores were 11.27 ± 4.26 (mean \pm SD) in males and 12.05 ± 5.23 in females. The
7 items were scored according to the OR values. In this study, the correlations between “taking a
8 walk” and “doing exercise” were 0.6252 in males and 0.5746 in females. Therefore, a latent
9 variable, “physical activity,” drawn from these two variables was used, which was the same as
10 confounders of “marital status” and “living arrangement” (r : 0.8074 in males and 0.6443 in females).
11 A latent variable (family status) was obtained. The scores are shown in Table 2. The scores of
12 demographic characteristics and health status are shown in Appendix B.
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20 SEM examinations for confirming the effects of behavioral and social-psychological factors were
21 performed separately in males and females. The results are shown in Figures 1 and 2. SEM analysis
22 revealed that the latent variable (physical activity) had the highest association with the IADL score
23 in both males and females. The standardized parameter estimate (β) was -0.34 in males and -0.33
24 in females. In males, the IADL score was associated with feeling lonely, worrying about falling,
25 alcohol consumption, falling in the last year, and participating in entertainment, with adjustments
26 for family status, age, chronic disease, chewing ability, daily sleep time, visual ability, and sleep
27 quality. The goodness of fit (GFI, CFI, TLI and RMSEA) was 0.917, 0.824, 0.763 and 0.083
28 respectively. In females, the IADL score was associated with falling in the last year and worrying
29 about falling, with adjustments for ethnicity, daily sleep time, family status, age, visual ability,
30 chronic disease, pension, and hearing ability. The goodness of fit (GFI, CFI, TLI and RMSEA) was
31 0.920, 0.845, 0.764 and 0.093 respectively.
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45 DISCUSSION

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47 Among the elderly in urban areas in Liaoning Province, the prevalence of independence in daily
48 living ability was 43.5%. The independence in daily living ability was significantly lower than the
49 level (54.8%) observed in the elderly living in urban areas in Shanghai,¹⁷ even though the average
50 age of our study population (73.2 years) was much younger than the population in Shanghai (78.44
51 years). In addition, independent living ability in females (41.1%) was lower than males (46.3%),
52 which was consistent with the results of the urban elderly in Suzhou;¹² however, the life
53 expectancy of females (79.4) was longer than males (73.6) according to the China Yearbook,²⁰ thus
54 suggesting that more attention should be paid to maintaining independent living for a longer time in
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2 elderly females. These findings indicated that the independent living ability among the urban
3 elderly in Liaoning province is still at a low level. In this study, the sample size was sufficiently
4 large and information bias was controlled as sufficient as possible because both dementia and
5 cognitive function screening with MMSE were conducted. Meanwhile, even if CFI and TLI were
6 not achieved the target value of 0.9, their values were still over 0.7, which indicated that the
7 goodness of fit of SEM model was still acceptable. All these facts increased the generalization of
8 our conclusions. Our results suggested that maintaining/improving independent living ability of the
9 elderly, especially females, should be essential part of providing healthcare for the aged population.

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18 With respect to the behavioral factors, physical activity was reported to not only maintain
19 physical health of the elderly, but also prevent elderly from acquiring mental diseases.²¹ In our
20 study, taking a walk and doing exercise were considered to measure physical activity among the
21 elderly; however, due to the high agreement between walking and doing exercise, previous studies
22 have usually selected one item to enter into the multiple model while assessing their effects. In this
23 study, the kappa value between taking a walk and doing exercise was also high (0.546). Of note, we
24 are not satisfied with this type of adjustment because taking a walk and doing exercise require
25 different intensities of activity. This kind of assessment was expected to weaken the effect of
26 physical activity. Thus, we used the latent variable, physical activity, to represent the effects of both
27 taking a walk and doing exercise. As a result, physical activity was shown to have the strongest
28 association with IADL in both males and females. Although health status was reported to be crucial
29 for the quality of life of the elderly in our previous study¹⁸ and the presence of chronic disease was
30 well-documented as the basis of any disorder,^{22 23} the associations with the IADL score were
31 weaker than physical activity. We also compared the effect of the latent variable with the effects of
32 original observed variables. When taking a walk was entered the model instead of physical activity,
33 the parameter estimate was lower (-0.233 in males and -0.228 in females) in comparison to physical
34 activity, same to doing exercise (-0.253 in males and -0.244 in females). It conversely proved that
35 the previous adjustment did weaken the effect of physical activity. Furthermore, we found that the
36 more frequent the elderly performed physical activity, the stronger the effect on the independent
37 living ability. Thus, any type of activity should be advocated for the independence of the elderly
38 regardless of health status.

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59 With respect to behavioral factors, falling in the last year and worrying about falling were also
60 associated with independent living ability in both males and females. The experience of falling in

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2 the last year may be an indicator for the decline of muscle strength, coordination, balance, and
3 flexibility,²⁴ which tended to be a potential threat for fractures and becoming bedridden among the
4 elderly.²⁵ Furthermore, because its significant correlation with visual ability (0.178 in males and
5 0.191 in females), its effect on health status also increased the possibility to affect the independent
6 living ability of the elderly. Indeed, worrying about falling will inevitably limit movement among
7 the elderly. Correspondingly, the effects on independent living ability were observed in both males
8 and females. Thus, we should pay more attention to the safety of daily routines. In addition, alcohol
9 consumption was shown to be significantly associated with IADL in males. Even if the elderly do
10 not consume alcohol excessively and measurement of alcohol consumption is inexact, the harmful
11 influence on the IADL score was shown. Moreover, usual alcohol consumption, rather than alcohol
12 use disorder, has been reported to be associated with notable cognitive, social and psychological
13 consequences in later life.^{26 27} Those negative effects together with our result indicated that
14 conclusion on alcohol consumption should be made with caution for the elderly. Therefore, guiding
15 the elderly to avoid alcohol seems to be able to contribute to independent living ability.

16
17 In comparison to behavioral factors, the effects of social-psychological factors on independent
18 living ability of the elderly were weaker with adjustment for demographic characteristics and health
19 status. A previous study reported that social participation enhanced the ability of the elderly to live
20 independently.²⁸ In this study, feeling lonely and participating in entertainment were shown to be
21 significantly associated with independent living ability, but only in males. This finding might be
22 caused by the Chinese traditional gender-role attitude “men go out to work and women stay at
23 home.” This attitude believes that men are more suitable for job, earning money and social
24 engagement; whereas women are more suitable for housework and taking care of family members.
25 Even if the society has developed well in China, this gender-role attitude does not change a lot,
26 especially for the elderly.²⁹ Thus, even if almost half of females would go out and enjoy some
27 entertainment, the animated atmosphere seemed to be more effective in keeping males in good
28 physical and mental health compared to females, who are accustomed to being confined to be at
29 home.

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31 As for the confounders, their effects had been well documented in the studies performed in China.
32
33¹⁰⁻¹² In the current study, ethnicity was found to be the second strongest factors associated with
34 independent living ability among females. This ethnicity-related difference might be due to the
35 under development of social security and strong consciousness of clan and family of minority.³⁰

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2 which reflected the vulnerability of the elderly-care policy in minority area. Among our study
3 population, the minority was less than 5% in males. Thus, ethnic effect was not analyzed among
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6 males.
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8 There were some limitations in our study. First, the measurements of several assessed factors
9 were too broad and simplistic, such as smoking and alcohol consumption. Second, even if our study
10 was a population-based study, it was limited by the cross-sectional design. Therefore, a prospective
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12 study is required to draw any causal conclusions.
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17 **CONCLUSION**

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19 Our results showed that independent living ability among the elderly in urban areas in Liaoning
20 Province in China is at a low level. Physical activity has an important role in maintaining and/or
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22 improving independent living ability of the elderly, even if health status has a crucial effect.
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24 Social-psychological factors, such as feeling lonely and participating in entertainment, could affect
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26 independent living ability among elderly males. Our findings suggest that gender-specific
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28 healthcare should be adopted as part of health promotion for the elderly. Physical activity of any
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30 type should be encouraged to maintain and improve the independent living ability of the elderly.
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3 **Contributors:** WS designed the study and supervised the performance of study. BW and YW
4 collected the data, analyzed the data and wrote the manuscript. TZ and JH helped with cleaning the
5 data, giving advice on statistical analysis and revising the manuscript. LY coordinated data
6 collection. All authors have given final approval of the version to be published.
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12 **Funding:** This research was funded by the National Natural Science Foundation of China [grant
13 number: 81102193].
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18 **Disclaimer:** The funding agencies are not responsible for the opinions presented in the manuscript.
19 The funding bodies had no influence on the conduct of the study or the interpretation of the results.
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24 **Competing interest:** None declared.
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28 **Ethics approval:** The study protocol and informed consent form received ethics approval from the
29 Committee on Human Experimentation at the China Medical University. Written informed consent
30 concerning conduct of the survey was obtained from each participant.
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35 **Provenance and peer review:** Not commissioned; externally peer reviewed.
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39 **Data sharing statement:** No additional data sharing available.
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Table 1 Univariate analysis of IADL scale (independence) in relation to behavioral factors and social-psychological factors.

Variables	Males			Females		
	N	Independence (%)	OR(95%CI)	N	Independence (%)	OR(95%CI)
Total	1726	46.3		1960	41.1	
Behavioral factors						
Smoking						
Yes	548	40.9		177	32.2	
Had ever	478	30.8	0.64(0.50-0.83)	270	30.7	0.93(0.62-1.41)
Never	696	61.1	2.27(1.81-2.85)	1512	44.0	1.65(1.19-2.30)
Alcohol consumption						
Yes	750	46.0		242	36.0	
No	969	46.4	1.02(0.84-1.23)	1716	41.8	1.28(0.97-1.70)
Taking a walk						
Almost none	325	27.1		283	9.90	
1-2 times/week	385	28.1	1.05(0.75-1.46)	421	30.4	3.98(2.56-6.19)
3-4 times/week	460	58.0	3.73(2.74-5.06)	488	48.6	8.60(5.60-13.20)
Almost everyday	556	60.4	4.11(3.05-5.54)	768	53.6	10.54(6.96-15.96)
Doing exercise						
Almost none	470	25.7		460	16.5	
1-2 times/week	354	36.4	1.65(1.23-2.23)	465	34.8	2.70(1.98-3.69)
3-4 times/week	452	52.9	3.24(2.45-4.27)	483	43.3	3.85(2.84-5.23)
Almost everyday	450	68.9	6.39(4.79-8.51)	552	64.9	9.32(6.90-12.61)
Regular diet						
No	201	32.8		289	22.1	
Yes	1525	48.1	1.89(1.39-2.58)	1671	44.3	2.80(2.09-3.76)
Falling in the last year						
Yes	162	35.2		295	16.9	
No	1562	47.4	1.66(1.18-2.32)	1664	45.4	4.07(2.96-5.60)
Worrying about falling						
Yes	681	24.2		870	25.3	
No	1043	60.6	4.81(3.88-5.96)	1086	53.8	3.44(2.83-4.17)
Social-psychological factors						
Feeling lonely						
Yes	232	28.9		332	23.8	
Not clear	354	26.0	0.87(0.60-1.25)	385	23.1	0.96(0.68-1.36)
No	1124	55.9	3.12(2.29-4.24)	1228	51.3	3.37(2.56-4.45)
Participating in entertainment						
No	613	24.5		815	30.2	
Yes	1109	58.3	4.32(3.47-5.38)	1139	48.8	2.21(1.83-2.67)
Watching TV often						
No	218	26.1		283	22.6	
Yes	1507	49.2	2.73(1.99-3.76)	1674	44.1	2.70(2.01-3.63)
Filial piety						
So so/bad	176	21.0		165	20.0	
Good	625	40.6	2.57(1.73-3.82)	673	40.0	2.66(1.77-4.02)
Very good	907	55.7	4.72(3.21-6.94)	1108	45.3	3.31(2.22-4.94)

Note. OR: Odd ratio; 95%CI: 95% confidence interval.

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Table 2. The description of scores of IADL and assessed factors.

Variables	Males		Females	
	N	Mean±SD	N	Mean±SD
IADL score	1726	11.27±4.26	1960	12.05±5.23
Behavioral factors				
Smoking	1722	1.41±0.72	1959	1.50±0.29
Alcohol consumption	1719	1.01±0.01	1958	1.25±0.09
Taking a walk	1726	2.74±1.44	1960	7.27±3.56
Doing exercise	1726	3.12±2.11	1960	4.45±3.21
Regular diet	1726	1.79±0.29	1960	2.54±0.64
Falling in the last year	1724	1.60±0.19	1959	3.61±1.10
Worrying about falling	1724	3.30±1.86	1956	2.35±1.21
Social-psychological factors				
Feeling lonely	1710	2.36±1.05	1945	2.49±1.16
Participating in entertainment	1722	3.14±1.59	1954	1.70±0.60
Watching TV often	1725	2.51±0.58	1957	2.46±0.60
Filial piety	1708	3.55±1.32	1946	2.89±0.65

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3 Figure 1. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in
4 males. Data was shown as standardized estimate (standard errors).
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7 Figure 2. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in
8 females. Data was shown as standardized estimate (standard errors).
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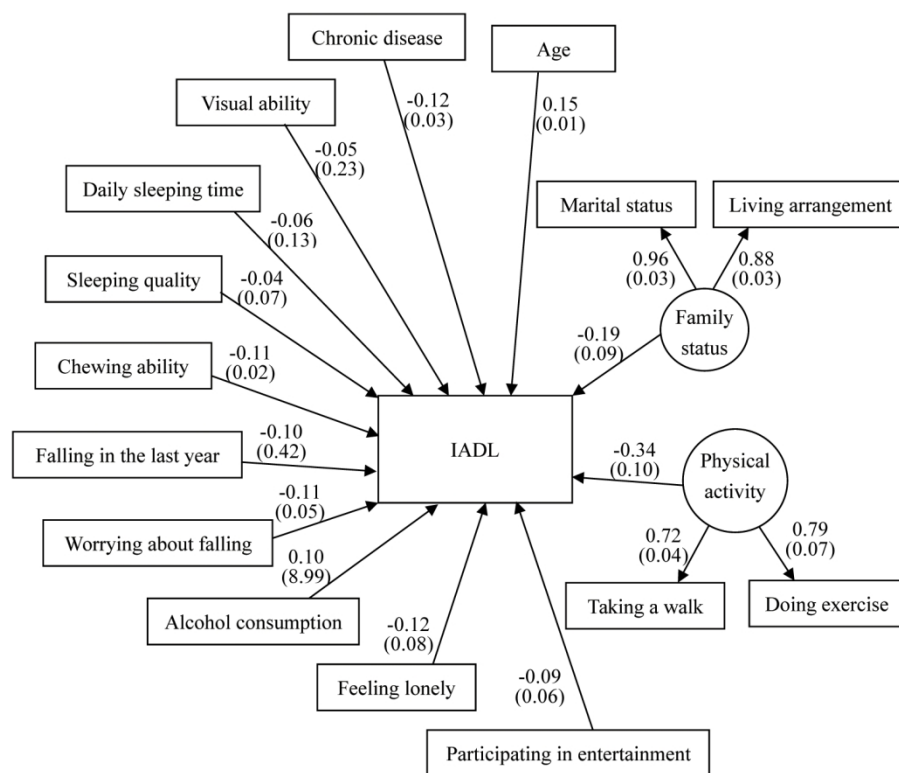


Figure 1. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in males. Data was shown as standardized estimate (standard errors).

150x119mm (300 x 300 DPI)

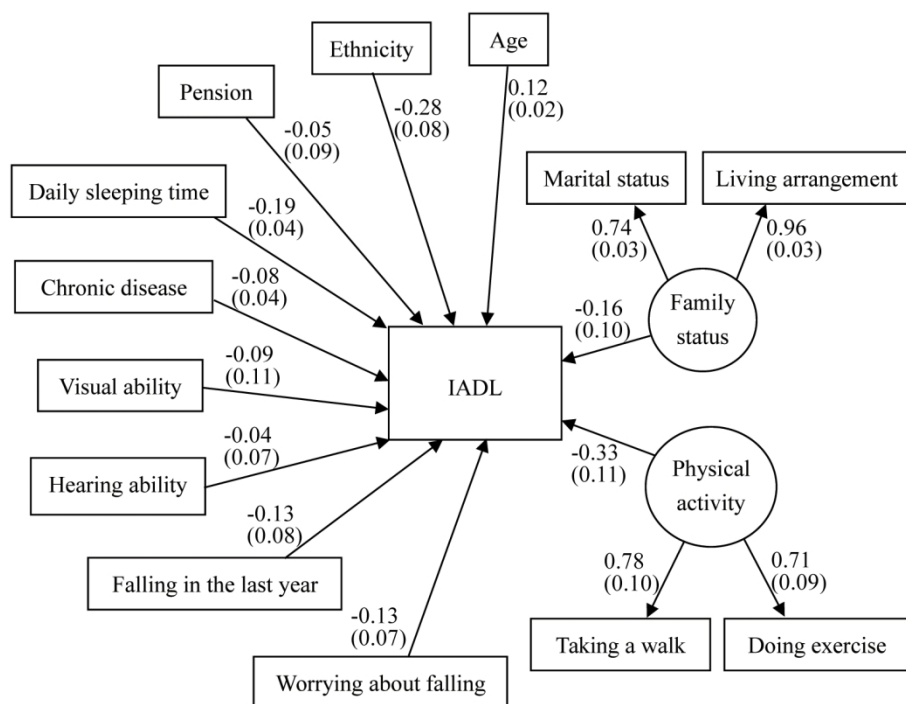


Figure 2. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in females. Data was shown as standardized estimate (standard errors).

150x119mm (300 x 300 DPI)

Appendix A. Distribution of IADL scale (independence) in demographic characteristics and health status.

Variables	Males			Females		
	N	Independence (%)	OR(95%CI)	N	Independence (%)	OR(95%CI)
Demographic characteristics						
Age						
75+	580	30.0		814	19.4	
65-74	1146	54.5	2.80(2.26-3.46)	1146	56.5	5.38(4.37-6.64)
Ethnicity						
Minority	-	-		269	15.2	
Han	-	-	-	1690	45.1	4.58(3.24-6.47)
Marital status						
Other	302	20.5		470	20.6	
Married/cohabitation	1423	51.8	4.16(3.09-5.60)	1490	47.5	3.48(2.72-4.45)
Living arrangement						
Living alone	184	21.7		227	30.8	
Living with spouse	1230	54.1	4.25(2.94-6.14)	1159	53.4	2.57(1.90-3.49)
Living with spouse and children	184	37.0	2.11(1.33-3.35)	327	26.9	0.83(0.57-1.20)
Living with children	126	19.8	0.89(0.51-1.56)	243	11.1	0.28(0.17-0.46)
Pension						
Haven't	116	36.2		188	16.0	
Have	1606	47.0	1.56(1.06-2.31)	1769	43.6	4.08(2.73-6.09)
Health status						
Chronic disease						
Present	1264	34.2		1529	31.9	
Not present	462	79.4	7.44(5.77-9.59)	431	73.5	5.93(4.67-7.54)
Visual ability						
Impaired	691	37.9		844	28.1	
Good	1030	51.8	1.76(1.45-2.15)	1112	50.9	2.66(2.19-3.21)
Hearing ability						
Impaired	763	29.4		853	23.2	
Good	957	59.7	3.56(2.91-4.36)	1102	54.9	4.03(3.30-4.91)
Daily sleeping time						
<4/>8 hours	110	28.2		210	11.4	
4-6 hours	906	42.4	1.88(1.21-2.90)	977	40.0	5.17(3.32-8.06)
6-8 hours	710	54.1	3.00(1.93-4.67)	769	50.5	7.89(5.04-12.35)
Sleeping quality						
Bad	765	30.2		968	27.4	
Good	961	59.1	3.34(2.73-4.08)	992	54.4	3.17(2.63-3.83)
Chewing ability						
Bad	426	20.7		651	15.5	
Middle	903	44.9	3.12(2.39-4.09)	989	46.0	4.64(3.63-5.94)
Good	396	77.3	13.06(9.37-18.20)	317	78.2	19.60(13.92-27.52)

Note. OR: Odd ratio; 95%CI: 95% confidence interval.

Appendix B. The description of scores of demographic characteristics and health status.

Variables	Males		Females	
	N	Mean±SD	N	Mean±SD
Demographic characteristics				
Age	1726	72.87±5.84	1960	73.55±5.82
Ethnicity	--	--	1959	4.09±1.23
Marital status	1725	3.61±1.20	1960	2.89±1.06
Living arrangement	1724	3.43±1.33	1956	1.81±0.93
Pension	1722	1.53±0.14	1957	3.78±0.91
Health status				
Chronic disease	1726	2.72±2.85	1960	2.08±2.04
Visual ability	1721	1.46±0.37	1956	1.94±0.82
Hearing ability	1720	2.42±1.27	1955	2.71±1.50
Daily sleeping time	1726	2.28±0.64	1956	5.79±2.10
Sleeping quality	1726	2.30±1.16	1960	2.10±1.09
Chewing ability	1725	4.88±4.55	1957	5.85±6.25

BMJ Open

The prominent effect of physical activity on independent living ability among community-dwelling elderly in urban areas of Liaoning Province in China: a population-based study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023543.R2
Article Type:	Original research
Date Submitted by the Author:	06-Jun-2019
Complete List of Authors:	Wang, Bowen; China Medical University, Social Medicine, School of Public Health Wu, Yijiao Zhang, Tianjiao; China Medical University, Social Medicine, School of Public Health Han, Jinsong; China Medical University, Social Medicine, School of Public Health Yu, Lianzheng; Liaoning Provincial Center for Disease Control and Prevention, Shenyang, PR China., Department of Noncommunicable Chronic Disease Prevention Sun, Wei; China Medical University, Social Medicine, School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

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3 **The prominent effect of physical activity on independent living ability among**
4 **community-dwelling elderly in urban areas of Liaoning Province in China: a**
5
6 **population-based study**
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ABSTRACT

Objective Independent living ability is crucial for the elderly; however, its assessment performed in China employs various scales and lacks risk factors, especially behavioral and social-psychological factors, which could be improved through health education. This study aimed to assess the independent living ability of community-dwelling elderly in urban areas of China and to identify the association with behavioral and social-psychological factors.

Design A population-based study using random cluster sampling method was performed in two core cities in Liaoning Province during March-November 2012.

Study population 3686 individuals who were ≥ 65 years old, had no dementia and cognitive impairment, had lived in the sampled communities for ≥ 5 years, and could take part in the study were enrolled.

Main outcome measures Interviews were conducted to collect information of independent living ability, indicated by the instrumental activity of daily living (IADL), behavioral factors, social-psychological factors, and confounders (demographic characteristics and health status). The mini-mental state examination was used to screen for cognitive impairment.

Results The independence rate was 46.3% in males and 41.1% in females. Structural equation modeling analysis showed that physical activity, drawn from taking a walk and doing exercise, had the strongest association with the IADL in both males (-0.34, SE 0.10) and females (-0.33, SE 0.11). Falling in the last year and worrying about falling were also significantly associated with IADL. The effects of regular drinking, feeling lonely, and participating in entertainment were significant in males.

Conclusion The independent living ability of the elderly in urban areas in Liaoning Province in China was at a low level. Physical activity was one of the important roles in both males and females; whereas the role of social-psychological factors only existed in males. Gender-specific health care and education to avoid sedentary life should be advocated for the elderly to maintain/improve their independent living ability.

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Strengths and limitations of this study

- ▶ The Lawton IADL scale was applied in this study, which has been used worldwide to indicate independent living ability of the elderly.
- ▶ The effects of behavioral and social-psychological factors that could be improved through health education in daily life were assessed among a Chinese population with adjustment for demographic characteristics and health status, whereas the measurements of smoking and regular drinking were broad and simplistic as the first attempt.
- ▶ Information bias was controlled as much as possible because the cognitive function of the elderly without dementia was further screened using the mini-mental state examination.
- ▶ Quantitative assessment through scoring measured factors according to the OR values was conducted and the effects on IADL were confirmed by structural equation modeling analysis.

INTRODUCTION

A significant change in the age structure of the world's population has resulted from population aging,¹ and has become a global issue in the 21st century.^{2 3} China is a nation with the largest aging population, which accounts for one-fifth of the total elderly population worldwide.⁴ Indeed, it has been estimated that China will experience the most rapid rate of aging in the world over the next 2–3 decades.¹ Thus, how to cope with problems caused by population aging has become particularly important for the development of China.

For the elderly, independence in daily life reduces nursing demands, decreases the consumption of medical resources, and improves the quality of life. Even if the loss of independent living ability is inevitable for the elderly, maintaining and/or improving this ability, even for short time, can postpone the onset of dependency and reduce the enormous social burden. Thus, focusing on the independent living ability among the elderly prior to death or becoming ill is important.

Previous studies involving the independent living ability of the elderly have been conducted in developed countries.⁵⁻⁹ The factors associated with the independent living ability of the elderly have been shown to be demographic characteristics (age, gender, ethnicity, marital status, education, and living arrangement), health status (chronic disease, visual ability, and hearing ability), behavior factors (smoking, alcohol consumption, taking a walk, doing exercise, and falling risk), and social-psychological factors (social integration, depressive symptoms, and social activity). Related studies have also been conducted in China;¹⁰⁻¹² however, various scales were used to indicate independence. As a result, the rate of dependency ranged from 7.9%-53.9%. The risk factors were limited to demographic characteristics and chronic disease. As for behavioral and social-psychological factors, health education interventions for smoking, respiratory function exercise, diabetes-related activity, anxiety, and family support had already been identified to improve health status of the elderly.¹³⁻¹⁵ Thus, these factors should also be studied from the perspective of independent living ability. Unfortunately, those educational risk factors in daily life were not considered in China. In addition, cognitive function screening was rarely considered in international and domestic studies, which was insufficient with respect to excluding information bias, especially for the aged population.

The purpose of this study was to conduct a population-based study to assess the independent living ability among the elderly without cognitive impairment in China, and to clarify the effects of behavioral and social-psychological factors with adjustment for demographic characteristics and

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2 health status. As a first attempt, we initially focused our attention on the elderly in urban areas. We
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4 believe our findings will provide help for the healthcare system to properly cope with population
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6 aging.
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10 **METHODS**

11 **Study area and population**

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14 According to the China Yearbook, the income level in Liaoning Province is similar to the
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16 national average. Shenyang city and Anshan city are the core cities in Liaoning Province and
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18 represent the urban area according to the Liaoning Provincial Yearbook. Two districts in each city
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20 were randomly sampled and one community in each sampled district was randomly selected. People
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22 who were ≥ 65 years of age, had never be diagnosed as dementia by physicians, lived in the local
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24 area for ≥ 5 years, and volunteered to take part in this study comprised the study population (a
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26 total of 4701 individuals). Investigators were recruited from graduate students who majored in
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28 medical epidemiology and trained for 2 weeks with the purpose to control respondent bias.
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30 Face-to-face interview was conducted between March and November 2012. A total of 4057
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32 participants completed 80% and more of interview and were identified as effective responses. 644
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34 responses were defined as drop outs because the participants had something to do, lost patient to
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36 complete the interview, or declined to take part, although they agreed at the beginning. The
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38 effective response rate was 86.3%. Cognitive function was further screened with the mini-mental
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40 state examination (MMSE). Cognitive impairment was identified with consideration of education as
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42 follows: illiterate ≤ 17 , elementary ≤ 20 , middle/high school ≤ 22 , junior college and over ≤ 23 .
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44 In the current study, 3686 individuals without cognitive impairment were enrolled as the subjects.

45 **Measurement of independent living ability**

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47 The Lawton instrumental activities of daily living (IADL) scale has been widely used to assess
48
49 independent living ability of the elderly.¹⁶ It has been validated among elderly Chinese.¹⁷ The
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51 IADL scale has eight items assessing the ability to use the telephone, shop for daily necessities,
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53 prepare meals, handle finances, do housework, take medications, do laundry, and use public
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55 transportation. Responses to each item are coded as 1 (completely able), 2 (have some difficulty), 3
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57 (need help), or 4 (unable). The total score ranges from 8-32 to represent the level of living ability.
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59 The higher the score, the worse the independent living ability. Independence is defined only if the
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total score is 8.

Measurements of behavioral factors, social–psychological factors, and confounders

Behavioral factors included the following six items: (1) smoking; (2) regular drinking; (3) taking a walk; (4) doing exercise; (5) regular diet; and (6) falling in the last year. Smoking was measured with answers of “Yes,” “Had ever,” or “Never.” Regular drinking was examined by asking “Do you drink regularly (twice or more a week for more than a year)?”. The responses were categorized as “Yes” or “No.” Taking a walk and doing exercise (including Tai chi chuan, jogging, running, riding a bike, swimming, and playing shuttlecock, and table tennis), were divided into four groups on the basis of frequency: almost none; 1-2 times/week; 3-4 times/week; and almost every day.¹⁸ Regular diet was measured by asking “Do you have breakfast, lunch and dinner on time and rarely skip meals?”. Falling in the last year was defined as “Yes” or “No.”

Social-psychological factors consisted of the following five items: (1) feeling lonely; (2) participating in entertainment; (3) watching television often; (4) worrying about falling; and (5) filial piety. Feeling lonely was assessed according to an individual’s perception and was categorized as “Yes,” “Not clear,” or “No.” Information on participating in entertainment and watching television often was examined by asking “Do you always hang out and play cards, chess, mahjong, or some other entertainment?”¹⁸ and “Do you watch television almost every day?”. Worrying about falling was defined as “Yes” or “No.” Filial piety is a prime virtue in Confucianism and advocated by Chinese traditional culture. The filial piety of children is expected to affect the health of the elderly. Thus, filial piety was included and assessed by asking “How do you feel about your children’s filial duty to you?”. The responses “So so” and “Bad” accounted for 8.8% and 0.4% of responses, respectively. These responses were combined into one group.

Confounders included factors of demographic characteristics and health status. Demographic characteristics included age, gender, ethnicity, marital status, living arrangement, pension, and health insurance. For marital status, the responses of “Single,” “Divorced,” and “Separation” were combined with “Widow” as the “Other” group because of the low response rate (<5%). Health status included chronic disease, visual ability,⁸ hearing ability,⁸ daily sleep time, sleep quality, and chewing ability.¹⁹ Chronic diseases were categorized as “Present” if any diseases, such as hypertension, cardiovascular disease, diabetes, stroke, liver cirrhosis, emphysema, rheumatoid arthritis, and chronic renal insufficiency, had been diagnosed. Visual ability was assessed to be “Impaired” if participants could not read the newspaper clearly regardless of wearing reading glasses. Hearing ability was defined as “Impaired” if voices for conversation or the volume for

1
2 watching television had to be raised. For daily sleep time, the responses “<4 hours” (2.7%) and “>8
3 hours” (6.0%) were combined as one group. Sleep quality measured the difficulty in falling asleep
4 or frequent awakening/dreaming.
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7 **Patient and public involvement**

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9 Only community residents were involved as participants in this study. They received the written
10 information about the conduct of the survey. However, they were not involved in the development
11 of the research question and outcome measures, the recruitment of subjects and the undertaking of
12 the study. After signing an informed consent, they were assessed for eligibility and data collection
13 was conducted.
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19 **Statistical analysis**

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21 Among all independent variables, health insurance in both males and females and ethnicity in
22 males were not considered in the data analysis because > 95% of the participants had the same
23 response.
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27 The association between IADL (independence) and each categorical variable was tested via a
28 chi-square test. The odds ratio (OR) was obtained by Mantel-Haenszel estimates. Then, the
29 quantitative values (scores) of these categorical variables were transformed according to the
30 corresponding OR value of each group. Those quantitative values were used to perform structural
31 equation modeling (SEM) to confirm the effect of factors measured on IADL score. Maximum
32 likelihood estimates was selected to fit SEM. While performing SEM analysis, variables that were
33 not statistically significant were eliminated with the purpose to simplify the model. Elimination was
34 conducted in the sequence of *p* value, one at a time. When a variable was eliminated, if the
35 goodness of fit became worse, the variable would remain in the model. In this study, no variable
36 was found to decrease the goodness of fit during elimination. The simplified SEM model was
37 shown and results are expressed as a standardized parameter estimate (β) with standard error (SE)
38 representing the association between dependent variable and independent variables. The goodness
39 of fit of model was indicated by the goodness-of-fit index (GFI), comparative fit index (CFI),
40 Tucker-Lewis index (TLI) and root mean square error of approximation (RMSEA). The proposed
41 values indicating high goodness of fit was GFI>0.8, CFI>0.9, TLI >0.9, and RMSEA<0.08.
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56 The agreement between categorical variables was evaluated with the Kappa test. If the Kappa
57 value was > 0.50, these variables were considered in agreement. As for quantitative values, Pearson
58 correlation was used to identify the collinear variables.
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2 The missing data were not handled because the missing rate was < 5%. But, they were excluded
3 when performing SEM model. SPSS for Windows (version 13.0) and AMOS (version 6.0) were
4 used for all statistical analyses.
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10 RESULTS

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12 Among 3686 subjects, the independence in males and females was 46.3% and 41.1%,
13 respectively. A total of 43.5% of individuals were independent. In comparison to the results (54.8%)
14 obtained from urban areas in Shanghai (n=2944),¹⁷ the level of independence was significantly
15 lower ($p<0.01$). The results of univariate analysis of the IADL scale (independence) are shown in
16 Table 1. Among the community-dwelling elderly in urban areas, the factors that were significantly
17 correlated with the IADL included smoking, taking a walk, doing exercise, regular diet, falling in
18 the last year, worrying about falling, feeling lonely, participating in entertainment, watching TV
19 often, and filial piety in both males and females. The distribution of IADL (independence) among
20 demographic characteristics and health status is shown in Appendix A.
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29 The average IADL scores were 11.27 ± 4.26 (mean \pm SD) in males and 12.05 ± 5.23 in females. The
30 items were scored according to the OR values. In this study, the correlations between “taking a
31 walk” and “doing exercise” were 0.6252 in males and 0.5746 in females. Therefore, a latent
32 variable, “physical activity,” drawn from these two variables was used, which was the same as
33 confounders of “marital status” and “living arrangement” (r : 0.8074 in males and 0.6443 in females).
34 A latent variable (family status) was obtained. The scores are shown in Table 2. The scores of
35 demographic characteristics and health status are shown in Appendix B.
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43 SEM examinations for confirming the effects of behavioral and social-psychological factors were
44 performed separately in males and females. The results are shown in Figures 1 and 2. SEM analysis
45 revealed that the latent variable (physical activity) had the highest association with the IADL score
46 in both males and females. The standardized parameter estimate (β) was -0.34 (SE: 0.10) in males
47 and -0.33 (SE: 0.11) in females. In males, the IADL score was associated with feeling lonely,
48 worrying about falling, regular drinking, falling in the last year, and participating in entertainment,
49 with adjustments for family status, age, chronic disease, chewing ability, daily sleep time, visual
50 ability, and sleep quality. The goodness of fit (GFI, CFI, TLI and RMSEA) was 0.917, 0.824, 0.763
51 and 0.083 respectively. In females, the IADL score was associated with falling in the last year and
52 worrying about falling, with adjustments for ethnicity, daily sleep time, family status, age, visual
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2 ability, chronic disease, pension, and hearing ability. The goodness of fit (GFI, CFI, TLI and
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4 RMSEA) was 0.920, 0.845, 0.764 and 0.093 respectively.
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8 **DISCUSSION**

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10 Among the elderly in urban areas in Liaoning Province, the prevalence of independence in daily
11 living ability was 43.5%. The independence in daily living ability was significantly lower than the
12 level (54.8%) observed in the elderly living in urban areas in Shanghai,¹⁷ even though the average
13 age of our study population (73.2 years) was much younger than the population in Shanghai (78.44
14 years). In addition, independent living ability in females (41.1%) was lower than males (46.3%),
15 which was consistent with the results of the urban elderly in Suzhou;¹² however, the life
16 expectancy of females (79.4) was longer than males (73.6) according to the China Yearbook,²⁰ thus
17 suggesting that more attention should be paid to maintaining independent living for a longer time in
18 elderly females. These findings indicated that the independent living ability among the urban
19 elderly in Liaoning province is still at a low level. In this study, the sample size was sufficiently
20 large and information bias was controlled as much as possible because both dementia and cognitive
21 function screening with MMSE were conducted. Although many potential reasons such as social
22 desirability might play a significant role for information bias control, especially for the examination
23 of alcohol consumption, cognitive impairment tended to be a prominent reason for information bias
24 of the elderly. In addition, assessment on alcohol consumption in this study was focused on regular
25 drinking habit instead of the exact consumption volume, because the probability of heaving drink
26 was low for the elderly. All these facts suggested that information bias could be controlled well and
27 the generalization of our conclusions could be increased. Our results suggested that
28 maintaining/improving independent living ability of the elderly, especially females, should be
29 essential part of providing healthcare for the aged population.
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49 While assessing the daily living ability of the elderly, the independent/dependent levels were the
50 same as the definition of independence only from the view point of health promotion. Because the
51 IADL score indicates the level of independent living ability, the IADL score tended to be more
52 valuable to quantitatively assess the associations between independent living ability and risk factors
53 reported. Thus, the SEM model was performed; however, the variables entered in SEM model
54 should be quantitative data, which became an obstacle for the assessment of categorical items. Thus,
55 quantitative transformation according to OR value was used to overcome this obstacle. Even if CFI
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3 and TLI did not achieve the target value of 0.9, the values were still over 0.7. As for RMSEA, the
4 values for both male and female models were slightly over the target value of 0.08, but still lower
5 than 0.1. According to the standards recommended by Steiger,²¹ the goodness of fit of the SEM
6 model was acceptable. Thus, we drew our conclusions based on the results of the SEM models.
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10 With respect to the behavioral factors, physical activity was reported to not only maintain
11 physical health of the elderly, but also prevent elderly from acquiring mental diseases.²² In our
12 study, taking a walk and doing exercise were considered to measure physical activity among the
13 elderly; however, due to the high agreement between walking and doing exercise, previous studies
14 have usually selected one item to enter into the multiple model while assessing their effects. In this
15 study, the kappa value between taking a walk and doing exercise was also high (0.546). Of note, we
16 are not satisfied with this type of adjustment because taking a walk and doing exercise require
17 different intensities of activity. This kind of assessment was expected to weaken the effect of
18 physical activity. Thus, we used the latent variable, physical activity, to represent the effects of both
19 taking a walk and doing exercise. As a result, physical activity was shown to have the strongest
20 association with IADL in both males and females. Although health status was reported to be crucial
21 for the quality of life of the elderly in our previous study¹⁸ and the presence of chronic disease was
22 well-documented as the basis of any disorder,^{23 24} the associations with the IADL score were
23 weaker than physical activity. We also compared the effect of the latent variable with the effects of
24 original observed variables. When taking a walk was entered into the model instead of physical
25 activity, the parameter estimate was lower (-0.233 in males and -0.228 in females) in comparison to
26 physical activity, and the same as doing exercise (-0.253 in males and -0.244 in females). These
27 results conversely proved that the previous adjustment did weaken the effect of physical activity.
28 Furthermore, we found that the more frequent the elderly performed physical activity, the stronger
29 the effect on the independent living ability. Thus, any type of activity should be advocated for the
30 independence of the elderly regardless of health status.
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51 With respect to behavioral factors, falling in the last year and worrying about falling were also
52 associated with independent living ability in both males and females. The experience of falling in
53 the last year may be an indicator for the decline of muscle strength, coordination, balance, and
54 flexibility,²⁵ which tended to be a potential threat for fractures and becoming bedridden among the
55 elderly.²⁶ Furthermore, because of the significant correlation with visual ability (0.178 in males and
56 0.191 in females), the effect on health status also increased the possibility to affect the independent
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2 living ability of the elderly. Indeed, worrying about falling will inevitably limit movement among
3 the elderly. Correspondingly, the effects on independent living ability were observed in both males
4 and females. Thus, we should pay more attention to the safety of daily routines. In addition, regular
5 drinking was shown to be significantly associated with IADL in males. Even if the elderly do not
6 consume alcohol excessively and measurement of alcohol consumption is inexact, the harmful
7 influence on the IADL score was shown. Moreover, usual alcohol consumption, rather than alcohol
8 use disorder, has been reported to be associated with notable cognitive, social and psychological
9 consequences in later life.^{27 28} Those negative effects together with our result indicated that alcohol
10 consumption should be made with caution for the elderly. Therefore, guiding the elderly to avoid
11 alcohol seems to be able to contribute to independent living ability.

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13 In comparison to behavioral factors, the effects of social-psychological factors on independent
14 living ability of the elderly were weaker with adjustment for demographic characteristics and health
15 status. A previous study reported that social participation enhanced the ability of the elderly to live
16 independently.²⁹ In this study, feeling lonely and participating in entertainment were shown to be
17 significantly associated with independent living ability, but only in males. This finding might be
18 caused by the Chinese traditional gender-role attitude “men go out to work and women stay at
19 home.” This attitude indicates that men are more suitable for a job, earning money and social
20 engagement, whereas women are more suitable for housework and taking care of family members.
21 Even if the society has developed well in China, this gender-role attitude does not change a lot,
22 especially for the elderly.³⁰ Thus, even if nearly one-half of females would go out and enjoy some
23 entertainment, the animated atmosphere seemed to be more effective in keeping males in good
24 physical and mental health compared to females, who are accustomed to being confined to be at
25 home.

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27 As for the confounders, the effects have been well documented in the studies performed in China.
28¹⁰⁻¹² In the current study, ethnicity was shown to be the second strongest factors associated with
29 independent living ability among females. This ethnicity-related difference might be due to
30 under-development of social security and strong consciousness of clan and the family of minority.
31³¹ which reflected the vulnerability of the elderly-care policy in minority area. Among our study
32 population, the minority was < 5% in males. Thus, ethnic effect was not analyzed among males.

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34 There were some limitations in our study. First, the measurements of several assessed factors
35 were too broad and simplistic, such as smoking and regular drinking. Second, even if our study was

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2 a population-based study, it was limited by the cross-sectional design. Therefore, a prospective
3 study is required to draw any causal conclusions.
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8 **CONCLUSION**

10 Our results showed that independent living ability among the elderly in urban areas in Liaoning
11 Province in China is at a low level. Physical activity has an important role in maintaining and/or
12 improving independent living ability of the elderly, even if health status has a crucial effect.
13 Social-psychological factors, such as feeling lonely and participating in entertainment, could affect
14 independent living ability among elderly males. Our findings suggest that gender-specific
15 healthcare should be adopted as part of health promotion for the elderly. Physical activity of any
16 type should be encouraged to maintain and improve the independent living ability of the elderly.
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3 **Contributors:** WS designed the study and supervised the performance of study. BW and YW
4 collected the data, analyzed the data and wrote the manuscript. TZ and JH helped with cleaning the
5 data, giving advice on statistical analysis and revising the manuscript. LY coordinated data
6 collection. All authors have given final approval of the version to be published.
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12 **Funding:** This research was funded by the National Natural Science Foundation of China [grant
13 number: 81102193].
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18 **Disclaimer:** The funding agencies are not responsible for the opinions presented in the manuscript.
19 The funding bodies had no influence on the conduct of the study or the interpretation of the results.
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24 **Competing interest:** None declared.
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28 **Ethics approval:** The study protocol and informed consent form received ethics approval from the
29 Committee on Human Experimentation at the China Medical University. Written informed consent
30 concerning conduct of the survey was obtained from each participant.
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35 **Provenance and peer review:** Not commissioned; externally peer reviewed.
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39 **Data sharing statement:** No additional data sharing available.
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Table 1 Univariate analysis of IADL scale (independence) in relation to behavioral factors and social-psychological factors.

Variables	Males				Females			
	N	Independence N (%)	OR(95%CI)	<i>p</i>	N	Independence N (%)	OR(95%CI)	<i>p</i>
Total	1726	799(46.3)			1960	805(41.1)		
Behavioral factors								
Smoking								
Yes	548	224(40.9)			177	57(32.2)		
Had ever	478	147(30.8)	0.64(0.50-0.83)	<0.01	270	83(30.7)	0.93(0.62-1.41)	0.04
Never	696	425(61.1)	2.27(1.81-2.85)	<0.01	1512	665(44.0)	1.65(1.19-2.30)	<0.01
Regular drinking								
Yes	750	345(46.0)			242	87(36.0)		
No	969	450(46.4)	1.02(0.84-1.23)	0.86	1716	718(41.8)	1.28(0.97-1.70)	0.08
Taking a walk								
Almost none	325	88(27.1)			283	28(9.90)		
1-2 times/week	385	108(28.1)	1.05(0.75-1.46)	0.77	421	128(30.4)	3.98(2.56-6.19)	<0.01
3-4 times/week	460	267(58.0)	3.73(2.74-5.06)	<0.01	488	237(48.6)	8.60(5.60-13.20)	<0.01
Almost everyday	556	336(60.4)	4.11(3.05-5.54)	<0.01	768	412(53.6)	10.54(6.96-15.96)	<0.01
Doing exercise								
Almost none	470	121(25.7)			460	76(16.5)		
1-2 times/week	354	129(36.4)	1.65(1.23-2.23)	<0.01	465	162(34.8)	2.70(1.98-3.69)	<0.01
3-4 times/week	452	239(52.9)	3.24(2.45-4.27)	<0.01	483	209(43.3)	3.85(2.84-5.23)	<0.01
Almost everyday	450	310(68.9)	6.39(4.79-8.51)	<0.01	552	358(64.9)	9.32(6.89-12.61)	<0.01
Regular diet								
No	201	66(32.8)			289	64(22.1)		
Yes	1525	733(48.1)	1.89(1.39-2.58)	<0.01	1671	741(44.3)	2.80(2.09-3.76)	<0.01
Falling in the last year								
Yes	162	57(35.2)			295	50(16.9)		
No	1562	740(47.4)	1.66(1.18-2.32)	<0.01	1664	755(45.4)	4.07(2.96-5.60)	<0.01
Worrying about falling								
Yes	681	165(24.2)			870	220(25.3)		
No	1043	632(60.6)	4.81(3.88-5.96)	<0.01	1086	584(53.8)	3.44(2.83-4.17)	<0.01
Social-psychological factors								
Feeling lonely								
Yes	232	67(28.9)			332	79(23.8)		
Not clear	354	92(26.0)	0.87(0.60-1.25)	0.44	385	89(23.1)	0.96(0.68-1.36)	0.83
No	1124	628(55.9)	3.12(2.29-4.24)	<0.01	1228	630(51.3)	3.37(2.56-4.45)	<0.01
Participating in entertainment								
No	613	150(24.5)			815	246(30.2)		
Yes	1109	647(58.3)	4.32(3.47-5.38)	<0.01	1139	556(48.8)	2.21(1.83-2.67)	<0.01
Watching TV often								
No	218	57(26.1)			283	64(22.6)		
Yes	1507	741(49.2)	2.73(1.99-3.76)	<0.01	1674	739(44.1)	2.70(2.01-3.63)	<0.01
Filial piety								
So so/bad	176	37(21.0)			165	33(20.0)		
Good	625	254(40.6)	2.57(1.73-3.82)	<0.01	673	269(40.0)	2.66(1.77-4.02)	<0.01
Very good	907	505(55.7)	4.72(3.21-6.94)	<0.01	1108	502(45.3)	3.31(2.22-4.94)	<0.01

Note. OR: Odd ratio, indicating the relative risk of independence prevalence in comparison to the first group of each item; 95%CI: 95% confidence interval.

Table 2. The description of scores of IADL and assessed factors.

Variables	Males		Females	
	N	Mean±SD	N	Mean±SD
IADL score	1726	11.27±4.26	1960	12.05±5.23
Behavioral factors				
Smoking	1722	1.41±0.72	1959	1.50±0.29
Regular drinking	1719	1.01±0.01	1958	1.25±0.09
Taking a walk	1726	2.74±1.44	1960	7.27±3.56
Doing exercise	1726	3.12±2.11	1960	4.45±3.21
Regular diet	1726	1.79±0.29	1960	2.54±0.64
Falling in the last year	1724	1.60±0.19	1959	3.61±1.10
Worrying about falling	1724	3.30±1.86	1956	2.35±1.21
Social-psychological factors				
Feeling lonely	1710	2.36±1.05	1945	2.49±1.16
Participating in entertainment	1722	3.14±1.59	1954	1.70±0.60
Watching TV often	1725	2.51±0.58	1957	2.46±0.60
Filial piety	1708	3.55±1.32	1946	2.89±0.65

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3 Figure 1. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in
4 males (N=1690). Data was shown as standardized estimate (standard errors).
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7 Figure 2. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in
8 females (N=1915). Data was shown as standardized estimate (standard errors).
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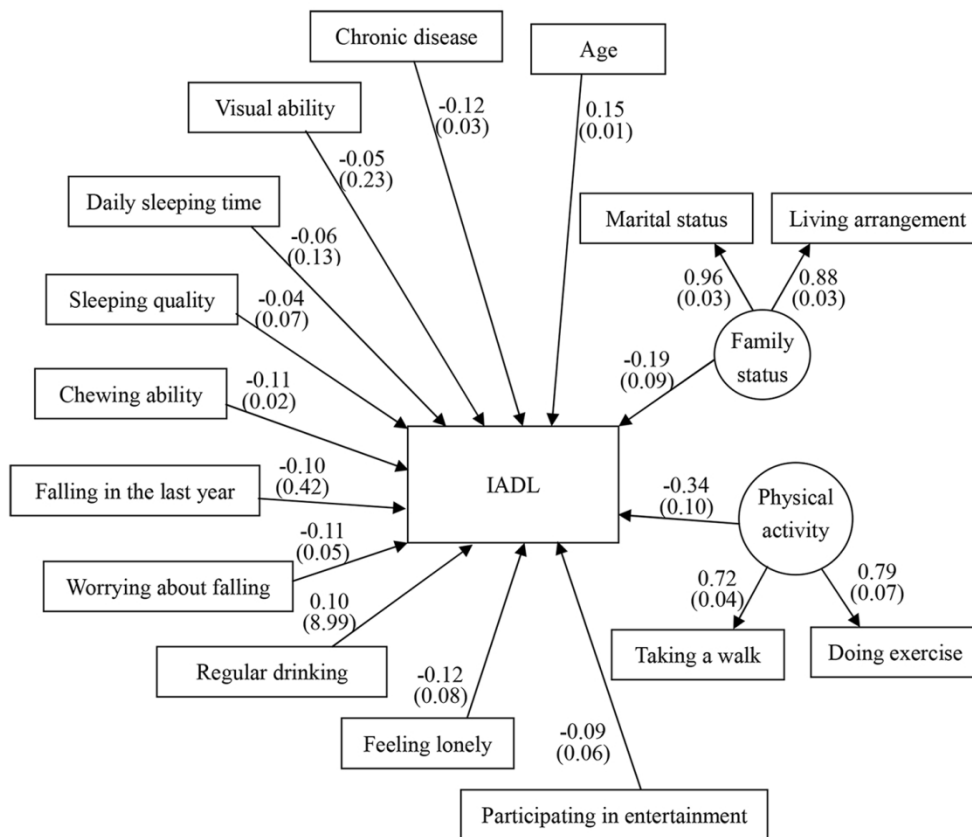


Figure 1. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in males (N=1690). Data was shown as standardized estimate (standard errors).

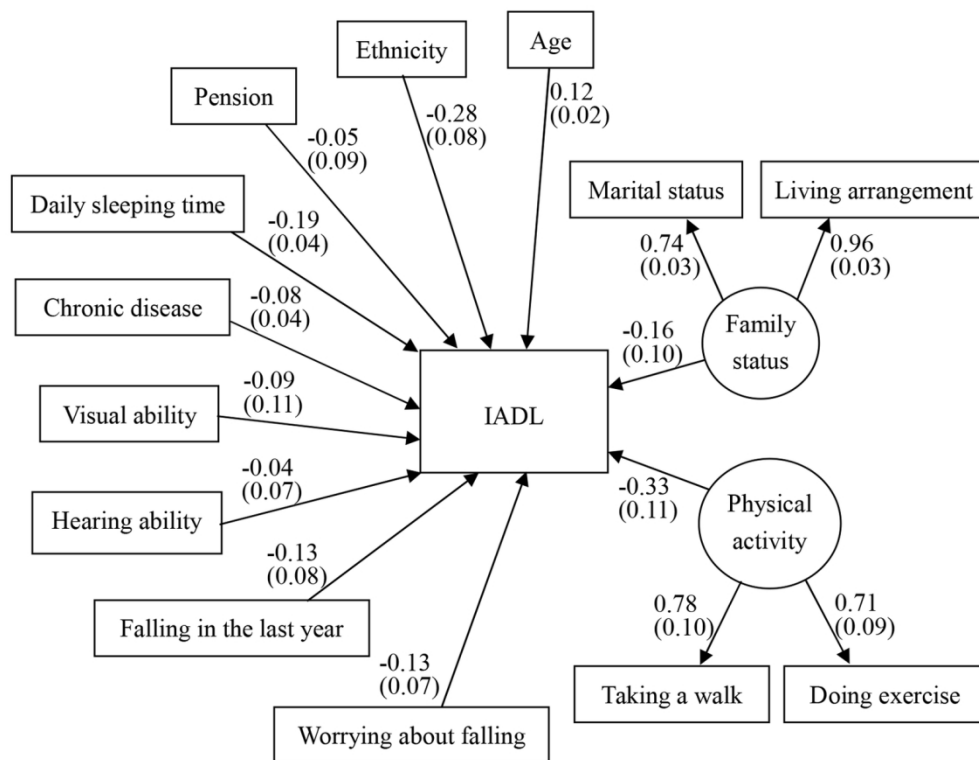


Figure 2. The SEM analysis for confirming the effects of behavioral factors and social-psychological factors in females (N=1915). Data was shown as standardized estimate (standard errors).

140x120mm (300 x 300 DPI)

Appendix A. Distribution of IADL scale (independence) in demographic characteristics and health status.

Variables	Males				Females			
	N	Independence N(%)	OR(95%CI)	<i>p</i>	N	Independence N(%)	OR(95%CI)	<i>p</i>
Demographic characteristics								
Age								
75+	580	174(30.0)			814	158(19.4)		
65-74	1146	625(54.5)	2.80(2.26-3.46)	<0.01	1146	647(56.5)	5.38(4.37-6.64)	<0.01
Ethnicity								
Minority	-	-			269	41(15.2)		
Han	-	-	-		1690	763(45.1)	4.58(3.24-6.47)	<0.01
Marital status								
Other	302	62(20.5)			470	97(20.6)		
Married/cohabitation	1423	737(51.8)	4.16(3.09-5.60)	<0.01	1490	708(47.5)	3.48(2.72-4.45)	<0.01
Living arrangement								
Living alone	184	40(21.7)			227	70(30.8)		
Living with spouse	1230	666(54.1)	4.25(2.94-6.14)	<0.01	1159	619(53.4)	2.57(1.90-3.49)	<0.01
Living with spouse and children	184	68(37.0)	2.11(1.33-3.35)	<0.01	327	88(26.9)	0.83(0.57-1.20)	0.31
Living with children	126	25(19.8)	0.89(0.51-1.56)	0.69	243	27(11.1)	0.28(0.17-0.46)	<0.01
Pension								
Haven't	116	42(36.2)			188	30(16.0)		
Have	1606	755(47.0)	1.56(1.06-2.31)	0.02	1769	772(43.6)	4.08(2.73-6.09)	<0.01
Health status								
Chronic disease								
Present	1264	432(34.2)			1529	488(31.9)		
Not present	462	367(79.4)	7.44(5.77-9.59)	<0.01	431	317(73.5)	5.93(4.67-7.54)	<0.01
Visual ability								
Impaired	691	262(37.9)			844	237(28.1)		
Good	1030	534(51.8)	1.76(1.45-2.15)	<0.01	1112	566(50.9)	2.66(2.19-3.21)	<0.01
Hearing ability								
Impaired	763	224(29.4)			853	198(23.2)		
Good	957	571(59.7)	3.56(2.91-4.36)	<0.01	1102	605(54.9)	4.03(3.30-4.91)	<0.01
Daily sleeping time								
<4/>8 hours	110	31(28.2)			210	24(11.4)		
4-6 hours	906	384(42.4)	1.87(1.21-2.90)	<0.01	977	391(40.0)	5.17(3.32-8.06)	<0.01
6-8 hours	710	384(54.1)	3.00(1.93-4.66)	<0.01	769	388(50.5)	7.89(5.04-12.35)	<0.01
Sleeping quality								
Bad	765	231(30.2)			968	265(27.4)		
Good	961	568(59.1)	3.34(2.73-4.08)	<0.01	992	540(54.4)	3.17(2.62-3.83)	<0.01
Chewing ability								
Bad	426	88(20.7)			651	101(15.5)		
Middle	903	405(44.9)	3.12(2.39-4.09)	<0.01	989	455(46.0)	4.64(3.63-5.94)	<0.01
Good	396	306(77.3)	13.06(9.37-18.20)	<0.01	317	248(78.2)	19.60(13.92-27.52)	<0.01

Note. OR: Odd ratio, indicating the relative risk of independence prevalence in comparison to the first group of each item; 95%CI: 95% confidence interval.

Appendix B. The description of scores of demographic characteristics and health status.

Variables	Males		Females	
	N	Mean±SD	N	Mean±SD
Demographic characteristics				
Age	1726	72.87±5.84	1960	73.55±5.82
Ethnicity	--	--	1959	4.09±1.23
Marital status	1725	3.61±1.20	1960	2.89±1.06
Living arrangement	1724	3.43±1.33	1956	1.81±0.93
Pension	1722	1.53±0.14	1957	3.78±0.91
Health status				
Chronic disease	1726	2.72±2.85	1960	2.08±2.04
Visual ability	1721	1.46±0.37	1956	1.94±0.82
Hearing ability	1720	2.42±1.27	1955	2.71±1.50
Daily sleeping time	1726	2.28±0.64	1956	5.79±2.10
Sleeping quality	1726	2.30±1.16	1960	2.10±1.09
Chewing ability	1725	4.88±4.55	1957	5.85±6.25

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	In my manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Page 1 in title and Page 2, Line 7-8
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, Line 12-21
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4, Line 2-28
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4, Line 29 to Page 5, Line 1
Methods			
Study design	4	Present key elements of study design early in the paper	Yes: Page 5, Line 23 to Page 7, Line 3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5, Line 7-10 and Line 14-15
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5, Line 10-13
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes: Page 5, Line 23 to Page 7, Line 3
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes, all are presented: Page 5, Line 23 to Page 7, Line 3
Bias	9	Describe any efforts to address potential sources of bias	Page 5, Line 11, 15-22
Study size	10	Explain how the study size was arrived at	We had introduced the prevalence of dependency (7.9%-53.9%) in the introduction section. According to the formula $N=100*(1-p)/p$, sample size of 1166 is large enough. In our study, totally we interviewed 4701 individuals, which is much more than the size calculated. Thus, we did not explain a lot about it.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 5, Line 29-31 and Page 7, Line 15-18
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Yes: Page 7, Line 14-18
		(b) Describe any methods used to examine subgroups and interactions	Page 7, Line 20-23
		(c) Explain how missing data were addressed	Page 8, Line 1-2
		(d) If applicable, describe analytical methods taking account of sampling strategy	None

		(e) Describe any sensitivity analyses	None
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 5, Line 12-13, 15-16, 22 and Page 8, Line 6
		(b) Give reasons for non-participation at each stage	Page 5, Line 16-18.
		(c) Consider use of a flow diagram	None
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and Appendix A
		(b) Indicate number of participants with missing data for each variable of interest	Tables 1 and 2 showed the actual number and the total number.
Outcome data	15*	Report numbers of outcome events or summary measures	Page 8, Line 6-7.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 8, Line 9 to Page 9, line 2; Table 1 and 2, Appendix A and B, and Figure 1 and 2.
		(b) Report category boundaries when continuous variables were categorized	None
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 12, Line 5-11.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 11, Line 30 to Page 12, Line 2.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9, Line 5 to Page 12, Line 2.
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 9, Line 14-22.
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 13, Line 6-7

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

1
2 available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at
3 <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is
4 available at www.strobe-statement.org.
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