Social isolation and Life satisfaction mediating the association of ADL and mild cognitive impairment in rural older adults: A multi-group SEM with latent response variable mediation analysis

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Research Article

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Abstract

Background: There are many studies on the relationship between daily activity ability (ADL) and mild cognitive impairment (MCI), and only the discussion of the relationship between ADL and MCI. However, the mechanism of the potential difference is very important to reduce the impact of cognitive dysfunction in later life. The purpose of this study was to investigate whether social isolation and life satisfaction mediated the relationship between ADL and MCI in the older adults.

Methods: A village-based cross-sectional study was conducted among 2,933 older adults people over 60 years old from Shandong Province, China. ADL, MCI, social isolation and life satisfaction were respectively assessed using the daily living capacity scale for Chinese, the Montreal Cognitive Assessment (MoCA) tool, the LSNS 6 scale and the Satisfaction with Life Scale questionnaire. The multi-group SEM with latent response variable method was conducted to evaluate the association between ADL and MCI mediated by social isolation and life satisfaction.

Results: The study found that daily activity ability was negatively correlated with mild cognitive impairment in the older adults. Further analysis of mediating effect found that social isolation and life satisfaction had a partial mediating effect between ADL and MCI in the older adults.

Conclusion: These results indicated that social isolation and life satisfaction may act as a partial mediator in the relationship between ADL and MCI, and the mediating effect of social isolation was more pronounced than that of life satisfaction.

Background

Mild Cognitive Impairment (MCI) has not yet reached the level of dementia, and is somewhere between normal aging and dementia[1]. Previous large cohort studies in Europe and the United States reported that the prevalence of MCI in persons aged ≥ 65 years was 7.7% ~ 28.3%, and increased with age[2]. Numerous studies have shown that the prevalence of MCI is not the result of a single factor, but of a combination of factors.

There is some evidence that social isolation is associated with poorer cognitive outcomes[3]. Good social relations may also increase cognitive reserve and prevent the decline of cognitive function[4, 5]. However, compared with other lifestyle factors, the relationship between social relationship and cognitive function is less clear, and the research results are contradictory[6]. Previous studies have shown that cognitive and physical functions are associated with life satisfaction[7, 8]. While these studies have demonstrated a link between life satisfaction and cognitive and physical functioning[9], all but one found such a link only in bivariate analyses. Recent research also confirms that daily life activities (ADL) has been found to be a strong predictor of progression to dementia in patients in the prodromal stage of AD[10, 11]. Elise Cornelis¹ et al.[12] pointed out that ADL assessment can not only be used as a diagnostic tool, but also as an indicator of future dementia risk.

There are many studies on the relationship between ADL and MCI, and only the discussion of the relationship between ADL and MCI, but the mechanism of the potential difference is very important to reduce the impact of cognitive dysfunction in later life[13]. Currently, there are few studies on the mechanism of action between ADL and MCI. Therefore, this study tries to explore the correlation between social isolation, life satisfaction, ADL and cognitive function. Although ADL, social isolation and life satisfaction are closely related to MCI, few studies have evaluated the direct influence of ADL on MCI mediated by social isolation and life satisfaction. So far, a paucity of research examines the relationship between ADL and MCI mediating by subjective life satisfaction and life satisfaction through multi-group SEM with latent response variable approach in rural older adults.

Methods

Study population

The cross-sectional, village-based survey was conducted in 17 cities Shandong Province, from February 2018 to September 2018. In 2017, there were 21.373 million people aged 60 or above in Shandong Province, accounting for 21.4% of the this population, 4.0 percentage points higher than the national average. There are 5 cities in Shandong province, which are divided into east (Yantai), south (Linyi), west (Liaocheng), north (Binzhou), central (Tai'an) according to geographical location. A two-stage cluster sampling method was adopted. First, 1 township was randomly selected from each city, and then 2 villages were selected from each township. Finally, 10 villages were selected in this study. Senior citizens who give informed consent in writing, could maintain good communication with interviewers, and have lived in their current homes/there for more than two years were included in the study. Excluded individuals were dementia, aphasia, severe deafness, old adults who could not answer questions, old adults with mental illness, old adults who refused the survey, did not complete the survey, or did not cooperate with the survey. A total of 2,933 older adults people were selected from 10 villages as research subjects.

Data collection/measurement of anthropometrics

All old adults were interviewed face-to-face by trained investigators who were undergraduates from Binzhou Medical University. Information on demographics, ADL, MCI, social isolation, life satisfaction, health-related behaviors and health status was collected by a structure questionnaire. During the survey, older adults subjects with memory impairment can be supplemented by accompanying family members to answer the questionnaire. The investigators have good investigation skills and rigorous working attitude, and they promise to keep the data confidential. The completed questionnaires were comprehensively audited to check their completeness, logicity and consistency.

Assessment of general information and covariates

The general information questionnaire contained sociodemographic variables, health-related behaviors and health-status were investigated in a unified and rigorous procedure. In this study, Sociodemographic characteristics include covariates such as age, sex, marital status, education, number of children, occupation, living arrangement, monthly income, economic domination, medical expenses burden,

etc., which are classified as follows: age(<70;70-80;≥45years) ,gender (male or female) ,marital status (couple vs. others), number of children(0;1;2;3+) ,occupation (manual labour or mental labour), education (primary school or below;junior school senior high school and above), living arrangement (living alone; spouse; spouse and offspring; pension institutions and others), monthly income(<1000;1000-2999; 3000-4999;≥5000RMB), economic domination (total; partial; no domination), medical expenses burden (individuals and governments). Health-related behavioral variables include smoking, drinking status, sleep duration and physical exercise frequency ,which are classified as follows: smoking status (non-smoking; smoking at present; smoking in the past), drinking status (no; yes), sleep duration (<5;5-10;≥10hours/day), physical exercise frequency(0;1-2; ≥3times/week).Smoking status refers to smoking at least one cigarette per day on average for 6 consecutive months or more, and smoking cessation status refers to smoking before but stopping smoking for more than 6 months[14].Drinking status were assessed by asking the participants whether they had drunk alcohol in the past 6 months[15].Health-status include BMI, NCDs, Self-reported health .Self-reported non-communicable diseases(NCDs) were also investigated, and NCDs in the past 1 year(yes vs. no).Weight and height were measured in this study and Body mass index(BMI) was calculated as weight(kg) divided by height (m) in square. Participants were divided into 4 categories(lean, normal ,overweight and obesity), according to the China criteria[16].Self-reported health status was assessed by asking the older adults "how do you feel about your current health?", which answers are classified as good, normal or bad.

Assessment of ADL

Activity of Daily Living(ADL) Scale[17]was applied to measure activity of daily living of the older adults. It consists of two parts: one is the physical self-maintenance scale (PSMS), which consists of six items: eating, going to the toilet, dressing, brushing, walking and taking a bath;The second item is the daily life tools activity scale (IADL), which includes 8 items: making phone calls, shopping, preparing meals, doing housework, washing clothes, using transportation, taking medicine and handling finances. The possible answers and their scores were: "I can do it all by myself" (1 point), "some difficulty" (2 point), "need help" (3 point), and "can't do it at all" (4 point).The total scores ranges from 14 to 56. The higher the total score of ADL, the lower the daily activity ability.

Assessment of social isolation

The Lubben Social Network Scale – 6 (LSNS-6) was used to measure social isolation status of the older adults. [18]. The LSNS-6 scale is mainly used for the screening of social isolation in older population, with good reliability and validity [11]. The scale is divided into two parts: "family module" and "friend module", each module consists of 3 items with equal weight. Each item contains "no", "1", "2", "3 ~ 4", "5 ~ 8" and "nine, or even more" six level of response, assignment of 0 ~ 5 points in turn. The scale total scores for each six items are summed and range from 0–30, with higher scores indicating closer social ties, and vice versa. Older people with overall scores below 12 are considered "socially isolated".

Assessment of life satisfaction

The Satisfaction with Life Scale (SWLS) scale was used to measure life satisfaction of the older adults [19]. The SWLS scale includes the following five items: [1] "My life is roughly in line with my ideals." [2] "My life is in full swing." [3] "I am satisfied with my life." [4] "Until now, I've been able to get the important things I wanted in life." [5] "There are few things I would change if I could live my life over again." Participants used a seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), to indicate how much they agreed or disagreed with each item.The overall Scores ranged from 5 to 35, with higher scores indicating higher life satisfaction.

Assessment of MCI

Mild cognitive impairment (MCI) in individuals over 60 years of age was measured using the Beijing version of the Montreal Cognitive Assessment(MoCA-BJ) tool[20], which is a revision of the English version of the Montreal cognitive assessment scale based on Chinese cultural background and language features, and is also one of the most widely used versions in China. The reliability and validity of the Chinese version of the MoCA-BJ have been confirmed. The scale includes eight dimensions: visual space/executive function, naming, memory, attention, language, abstraction, delayed recall, and orientation. In addition to the memory dimension, other dimensions, such as visual spatial executive ability (5 points in total), naming (3 points in total), attention (3 points in total), language (3 points in total), abstraction (2 points in total), delayed memory (5 points in total), directional force (5 points in total), are added together to make the total score of 30 points. Higher scores imply better cognitive function, and this scale has better reliability and validity when used to evaluate the cognitive function of the population [21, 22].Most studies have shown different thresholds, ranging from 16 to 26, although MoCA 's total score has been adjusted for education. In this study, 20 points were used as the cutoff value, and a score of <16 points was considered as mild cognitive impairment.

Ethical approval

The study protocol was approved by the Ethical Committee of Binzhou medical college(2017-070). The investigation was performed after the acquisition of informed consent from all participants.

Statistical analysis

The data were double-entered and checked using EpiData version 3.1(The EpiData Association,Odense,Denmark). Statistical analyses were performed using SPSS version 22.0(IBM Corp., Armonk, NY) and AMOS 22.0 (IBM Corp., Armonk, NY).Continuous variables were expressed as mean±SD and classified variables were expressed as frequencies and percentages. The comparison of continuous variables were analyzed by students' t test, while the chi-square test were carried out for classified variables. Pearson partial correlation coefficients were used to examine relationship among dimensions of daily activity ability, social isolation, life satisfaction, and each domains of MCI after controlling for other variables. Before regression analysis, multicollinearity diagnostics were conducted on all covariates and the two dimensions of ADL. Then, multivariable linear regression was used to evaluate the association between dimensions

of ADL and each dimensions of MCI after controlling for relevant covariates (model a) , further adjusting for social isolation (model b) , and finally after further adjusting for life satisfaction (model c).

Moderation analyses were conducted to determine whether social isolation and life satisfaction moderates the association between ADL and MCI. A multi-group SEM with latent response variable approach was conducted via AMOS 22.0 to explore how social isolation and life satisfaction might influence the association between ADL and MCI among senior citizen. Considering the measurement error and non-normality [14], social isolation and life satisfaction were considered as latent mediators variable in the mediation analysis. Given that relevant covariates (i.e., The controlled covariates were age, gender, education, occupation, marital status, number of offspring, monthly income, economic domination medical expenses burden living arrangement ,smoking status, alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health) may have influence on social isolation life satisfaction and MCI, these variables were adjusted in the mediation analysis. The mediation and moderated mediation model were analyzed using the PROCESS macro for SPSS [23]. The bias-corrected 95% confidence interval (CI) was calculated with 5000 bootstrapping re-samples [23, 24]. The indirect effect is statistically significant if the bias-corrected bootstrap CI doesn't include zero [24]. All statistical tests were two-tailed and a p value < 0.05 was considered as statistically significant.

Results

Characteristics of the study population

In this study, 2,933 older adults were divided into two groups based on whether or not they had mild cognitive impairment. Table 1 shows prevalence of MCI among rural older adults with different characteristics. The differences of age, gender, education, occupation, marital status, number of offspring, monthly income, economic domination medical expenses burden living arrangement , alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health, T scores of social isolation, ADL , life satisfaction, scores of relatives isolation , friends isolation , PSMS and IADL were statistically significant in the older adults with and without mild cognitive impairment ($p < 0.001$).

Correlations between ADL, social isolation, life satisfaction and MCI

The partial Pearson product moment correlations between ADL, social isolation, life satisfaction and MCI controlling for other covariates are summarized in Table 2. PSMS was negatively associated with Visuospatial abilities, Naming, Attention, Language, Abstraction, Delayed recall, Orientation, Relatives Isolation, Friends Isolation and life satisfaction, but was positively associated with IADL ($p < 0.001$). IADL was negatively associated with 7 domains of MCI , Two modules of social isolation and life satisfaction, but was positively associated with PSMS ($p < 0.001$).

Multicollinearity diagnosis

In order to identify the multicollinearity problem, we performed multicollinearity diagnosis before multiple linear regression analysis. Many studies have shown that tolerance value above 0.17 and VIF below 6 can be used to diagnose multicollinearity [25]. The results showed that all VIF were less than 4, and all tolerance values were greater than 0.5. Therefore, there is no sufficient evidence showing that the covariates and scores of ADL were in collinearity.

The relationship between ADL, social isolation, life satisfaction and MCI

Table 3 shows the results of multiple linear regression analysis. The results showed that only among old adults IADL was significantly negatively correlated with relatives isolation and friends isolation, which were the two modules of social isolation, after adjusting for age, gender, education, occupation, marital status, number of children, monthly income, economic domination, medical expenses burden, living arrangement, smoking status, alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health. Similarly, IADL was negatively correlated with life satisfaction after adjusting for the same covariate. model 4 is the association between MCI, social isolation and ADL by multiple linear regression. The results of multiple linear regression analysis still showed that IADL in the older adults was negatively associated with MoCA scores after controlling for the same covariates as above. By further adjusting for social isolation, the coefficients of IADL among old adults were slightly attenuated and the friends isolation was obviously positively related with MCI. Then, further adjusting for life satisfaction variables, the results still showed a negative correlation between IADL and MCI although the correlation coefficient was slightly reduced, and the friends isolation and life satisfaction were obviously positively related with MCI.

Mediation analysis

Fig. 1 displays our hypothesized relationships between ADL, social isolation , life satisfaction and MCI. All latent variables (denoted by ellipses) were adjusted for age, gender, education, occupation, marital status, number of offspring, monthly income, economic domination medical expenses burden living arrangement ,smoking status, alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health.

Fig. 1 were statistically significant ($p < 0.05$). The results of multi-group SEM with latent response variable mediator analysis are shown in Table 4. The multi-group SEM analysis revealed that there was a partial mediation effect in the relationship between ADL and MCI through social isolation and life satisfaction. The total effect, the direct effect of ADL, and the indirect effect through social isolation and life satisfaction were all significant. Moreover, the results illustrated a small and negative indirect effect with statistical significance existed in old adults (-0.016 , 95%CI: $(-0.023, -0.011)$), and the percentage of indirect effect on total effect was 16.67%. For the two intermediate variables in the analysis, social isolation accounted for 68.75% of the total indirect effect, which had a more significant intermediate effect than life satisfaction in the association between ADL and MCI. In addition, the CFI, TLI, RMSEA of the full samples model were 0.950, 0.943 and 0.060, respectively.

Discussion

Although studies have examined the relationships between ADL, social isolation, life satisfaction and MCI[2, 3], few studies have examined the relations of the four variables in a single model. To our knowledge, the current study is the first study to explore the role of social isolation and life satisfaction in the relationship between ADL and MCI in aged using the multi-group SEM with latent response variable approach.

It is well known that some aspects of social isolation are related to cognitive function in later life[3]. Social isolation may damage cognitive function, because isolated individuals have less social contact with others. These people may get less cognitive stimulation through social contact, which leads to the decrease of cognitive reserve and cognitive function[26]. The study also found that some significant and common changes in life, such as retirement, widowhood[27], financial constraints[28], mobility difficulties [29] and other factors may increase the risk of social isolation of the older adults. In the study, similar to others[30], the MCI of the older adults with severe social isolation was worse than that of the older adults with less social isolation.

Previous studies suggested that higher cognitive function was positively correlated with LSWS and positive emotion[31-33]. Most researchers believe that people with higher cognitive ability can better appreciate the subtle and positive aspects of life, or people are more suitable to use resources and adapt to the environment, so as to promote happiness. The longitudinal study conducted by Åsa Enkvist[9] et al. revealed the ability of life satisfaction of the older adults to predict cognitive ability. Our study also suggests that better life satisfaction can improve cognitive ability.

Studies have shown that ADL is a central marker of the diagnosis and progression of dementia syndrome[34]. A large number of studies have shown that IADL damage can predict the progression of dementia, and can be used to help distinguish dementia from early forms of cognitive decline, such as mild cognitive impairment[35]. Our data also shows that after controlling age, gender, education level, occupation, marital status, number of children, monthly income, economic control, medical cost burden, living standard and other factors, the older adults with IADL disorder have a relative relationship with MCI, and PSMS has a more obvious impact on MCI, which is consistent with previous studies[36]. However, when the effects of social segregation were controlled, the link between ADL and MCI was slightly diminished in the older adults. Further adjustment of subjective well-being variables, although the correlation coefficient slightly decreased, but still showed that IADL and MCI were negatively correlated.

As expected, the poor ability of daily activities had a negative impact on cognitive function through the poor life satisfaction of self perception, while the better ability of daily activities was the opposite in the older adults. This was consistent with previous studies[37] that poor daily activities lead to poor life satisfaction and cognitive impairment, while better daily activities improve life satisfaction and stimulate cognitive rehabilitation[9]. Similarly, poor ability of daily activities leads to serious social isolation[38], which further affects the cognitive function of the older adults, while better ability of daily activities promotes good social relations, which is related to cognitive repair. In addition, our intermediary analysis shows that social isolation and life satisfaction had an impact on the relationship between ADL and MCI, and the impact of ADL and MCI was partly mediated by social isolation and life satisfaction. Therefore, in addition to the pathways shown in our study, there might be other mediators that mediate the connection between ADL and MCI. However, as far as we know, the mechanism of other factors mediating the interaction between ADL and MCI has not been reported.

Although the size of indirect effects in the whole sample was relatively small, these indirect effects were indeed significant. Devaki B. Kotian[29] et al. showed that higher ADL dependency was an important factor associated with social isolation among the older adults. With the increase of dependence on ADL, the probability of being isolated from society also increases. Most studies have confirmed that there is a correlation between social connections and cognitive function in the older adults. Barnes [39] et al. Conducted a follow-up study on the older adults, which showed that there was a positive correlation between social contact and cognitive level of the older adults, and the risk of cognitive decline of the older adults with social isolation increased. Similarly, the relationship between the ability of daily activities and life satisfaction has been confirmed by many researches[40]. The limited ability of daily activities will inevitably affect the happy life experience of the individual, and then affect the cognitive ability of the older adults. The results indicate that improving the social relationship and life satisfaction of the older adults will help to improve their cognitive function.

There are also some limitations of the study needs to be addressed. First of all, the design of this study was cross-sectional, so a causal relationship between ADL and mild cognitive impairment mediated by social isolation and life satisfaction cannot be concluded, which needs to be confirmed by further prospective studies. Secondly, although strict quality control was applied at every step from data collection to data analysis, there might still be reporting bias. Although latent variable analysis was used to correct the bias of social isolation and life satisfaction to some extent after all, there is no objective measurement of social isolation and life satisfaction. Third, the mediating effect of social isolation and life satisfaction between ADL and mild cognitive impairment was partial, and other variables might exist in the mediating model.

Conclusion

In conclusion, these results indicated that social isolation and life satisfaction may act as a partial mediator in the relationship between ADL and MCI, and the mediating effect of social isolation was more pronounced than that of life satisfaction. Future research is warranted.

Abbreviations

BMI
Body mass index
ADL
Activities of daily living
MCI
mild cognitive impairment

CI
Confidence Interval
SD
Standard deviation
NCDs
non-communicable diseases

Declarations

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Author's contributions

The author confirms sole responsibility for the following: study conception and design, statistical analyses and interpretation of results, and manuscript preparation. The author(s) approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the article are available on reasonable request at jiagzh221@163.com.

Ethical approval and consent to participate

The study design was approved by the Ethical Committee of Binzhou medical college(2017-070). All older people signed informed consent before conducting a house-to-house survey.

Consent to publish

Not applicable.

Conflict of interest

The author declares that she has no competing interests.

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Tables

Table 1. Prevalence of MCI among Rural Elderly with Different Characteristics

^a others means those who are unmarried (0.5%), divorced (1.4%), widowed (22.8%).

Note: Data are presented by mean ± SD or frequencies (percentage).

Table 2. Correlations between ADL, social isolation and life satisfaction, and MCI controlling for other covariates

	1	2	3	4	5	6	7	8	9	10	11	12
ADL												
1.PSMS	1											
2.IADL	0.794***	1										
MCI												
3.Vsuo spatial abilities	-0.136***	-0.200***	1									
4.Naming	-0.139***	-0.186***	0.363***	1								
5.Attention	-0.187***	-0.246***	0.347***	0.322***	1							
6.Language	-0.135***	-0.178***	0.316***	0.258***	0.569***	1						
7.Abstraction	-0.098***	-0.128***	0.280***	0.252***	0.417***	0.459***	1					
8.Delayed recall	-0.086***	-0.136***	0.282***	0.215***	0.389***	0.391***	0.352***	1				
9.Orientation	-0.120***	-0.124***	0.186***	0.173***	0.448***	0.386***	0.345***	0.331***	1			
Social isolation												
10.Relatives	-0.081***	-0.085***	0.080***	0.075***	0.108***	0.115***	0.095***	0.080***	0.052**	1		
11.Friends	-0.085***	-0.137***	0.131***	0.102***	0.114***	0.130***	0.128***	0.152***	0.065***	0.572***	1	
12.life satisfaction	-0.188***	-0.222***	0.038*	0.059**	0.118***	0.070***	0.043*	0.102***	0.059**	0.212***	0.156***	1

Note: a The controlled covariates were age, gender, education, occupation, marital status, number of offspring, monthly income, economic domination, medical expenses burden, living arrangement, smoking status, alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health;

$p < 0.001$

$p < 0.01$

Table 3. Estimated standardized coefficients between ADL, social isolation, life satisfaction, and MCI controlling for other covariates in rural elderly

Variables	N(%)	MCI		χ^2	P
		Yes(%)	No(%)		
Observations	2933	638(21.8)	2295(78.2)		
Sex:					
Male	1393(47.5)	262(18.8)	1131(81.2)	13.511	0.000
Female	1540(52.5)	376(24.4)	1164(75.6)		
Age:					
<70	1028(35.0)	153(14.9)	875(85.1)	75.256	0.000
70-80	1432(48.8)	321(22.4)	1111(77.6)		
≥80	473(16.1)	164(34.7)	309(65.3)		
Marital status:					
Couple	2210(75.3)	425(19.2)	1785(80.8)	33.495	0.001
Others ^a	723(24.7)	213(29.5)	510(70.5)		
Occupation:					
Manual labour	1929(65.8)	475(24.6)	1454(75.4)	27.303	0.000
Mental labour	1004(34.2)	163(16.2)	841(83.8)		
Education:					
Primary school or below	1885(64.3)	500(26.5)	1385(73.5)	74.644	0.000
Junior school	653(22.3)	99(15.2)	554(84.8)		
High school and above	395(13.4)	39(9.9)	356(90.1)		
Monthly income(RMB):					
<1000	1748(59.6)	459(26.3)	1289(73.7)	57.661	0.000
1000~2999	840(28.6)	140(16.7)	700(83.3)		
3000~4999	250(8.5)	33(13.2)	217(86.8)		
≥5000	95(3.2)	6(6.3)	89(93.7)		
Economic domination:					
Total	1138(38.8)	215(18.9)	923(81.1)	32.495	0.000
Partial	1628(55.5)	359(22.1)	1269(77.9)		
No	167(5.7)	64(38.3)	103(61.7)		
Medical expenses burden:					
Governments	346(11.8)	55(15.9)	291(84.1)	7.905	0.005
individuals	2587(88.2)	583(22.5)	2004(77.5)		
Smoking:					
Non-smoking	1837(62.6)	411(22.4)	1426(77.6)	2.861	0.239
Smoking at present	820(28.0)	162(19.8)	658(80.2)		
Smoking in the past	276(9.4)	65(23.6)	211(76.4)		
Drinking:					
Yes	1132(38.6)	198(17.5)	934(82.5)	19.668	0.000
No	1801(61.4)	440(24.4)	1361(75.6)		
Sleep duration(hours/day):					
<5	204(7.0)	58(28.4)	146(71.6)	27.742	0.000
5-10	2316(79.0)	456(19.7)	1860(80.3)		
≥10	413(14.0)	124(30.0)	289(70.0)		

Physical exercise frequency(times/week):					
0	1409(48.0)	386(27.4)	1023(72.6)	53.948	0.000
1-2	906(30.9)	164(18.1)	742(81.9)		
≥3	618(21.1)	88(14.2)	530(85.8)		
Living Arrangement:					
Living alone	418(14.2)	115(27.5)	303(72.5)	39.928	0.000
Spouse	1574(53.7)	297(18.9)	1277(81.1)		
Spouse and offspring	534(18.2)	100(18.7)	434(81.3)		
offspring	384(13.1)	117(30.5)	267(69.5)		
others	23(0.8)	9(39.1)	14(60.9)		
Number of offspring:					
0	66(2.2)	18(27.3)	48(72.7)	15.244	0.002
1	242(8.3)	47(19.4)	195(80.6)		
2	934(31.8)	167(17.9)	767(82.1)		
3+	1691(7.7)	406(24.0)	1285(76.0)		
BMI:					
Lean	206(7.0)	64(31.1)	142(68.9)	18.291	<0.001
Normal	1518(51.6)	348(22.9)	1170(77.1)		
Overweight+	983(33.6)	184(18.7)	799(81.3)		
obesity	226(7.7)	42(18.6)	184(81.4)		
NCDs:					
Yes	1847(63.0)	433(23.4)	1414(76.6)	8.380	0.004
No	1086(37.0)	205(18.9)	881(81.1)		
Self-reported health:					
Bad	331(11.3)	89(26.9)	242(73.1)	17.547	0.000
Normal	2055(70.1)	463(22.5)	1592(77.5)		
Good	547(18.6)	86(15.7)	461(84.3)		
Social isolation :	14.9±5.0	13.2±5.2	15.4±4.9	-9.337	0.000
Relatives isolation	8.1±2.3	7.4±2.8	8.3±2.7	-7.425	0.000
Friends isolation	6.8±2.9	5.8±3.1	7.1±2.8	-9.287	0.000
ADL:	17.3±6.3	20.6±9.0	16.45±5.0	11.022	0.000
PSMS	6.8±2.0	7.6±3.1	6.5±1.5	8.454	0.000
IADL	10.6±4.6	13.0±6.3	9.9±3.7	11.643	0.000
Life satisfaction :	25.8±6.3	24.3±6.6	26.2±6.2	-6.401	0.000

	Social isolation				Life satisfaction		MCI					
	Relatives		Friends									
	Model1 ^a		Model2 ^a		Model3 ^a		Model4 ^a		Model4 ^b		Model5 ^c	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
ADL												
PSMS	-0.039	0.208	0.066	0.034	-0.034	0.270	0.025	0.402	0.015	0.607	0.016	0.59
IADL	-0.083	<0.0001	-0.195	<0.0001	-0.234	<0.0001	-0.273	<0.0001	-0.255	<0.0001	-0.245	<0.0
Social isolation												
Relatives							-	-	0.039	0.067	0.037	0.07
Friends							-	-	0.136	<0.0001	0.132	<0.0
Life satisfaction							-	-	-	-	0.039	0.02
R square/ adjusted R square							0.173	0.171	0.189	0.187	0.189	0.18

Note: ^a adjusting age, gender, education, occupation, marital status, number of offspring, monthly income, economic domination, medical expenses burden, living arrangement, smoking status, alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health;

b further adjusting social isolation;

c even further adjusting life satisfaction;

model1 is the association between relative isolation and ADL by multiple linear regression;

model2 is the association between friends isolation and ADL by multiple linear regression;

model3 is the association between life satisfaction and ADL by multiple linear regression;

model4 is the association between MCI, social isolation and ADL by multiple linear regression;

model5 is the association between MCI, social isolation, life satisfaction and ADL by multiple linear regression;

Table 4. Mediation analysis of ADL, social isolation, life satisfaction, and MCI

Hypothesized model	β	P Value	95% CI	CFI/TLI	χ^2	df	RMSEA/Wald (95% CI)
ADL → social isolation → MCI				0.950/0.943	1201.870	104	0.060(0.057, 0.063)
ADL → life satisfaction → MCI							
Total effect	-0.096	0.001	-0.114, -0.080				
Indirect effect	-0.016	0.001	-0.023, -0.011				
social isolation (Me1)	-0.011	0.001	-0.016, -0.007				
life satisfaction (Me2)	-0.005	0.001	-0.009, -0.002				
Direct effect	-0.080	0.001	-0.095, -0.067				

Note: adjusting age, gender, education, occupation, marital status, number of offspring, monthly income, economic domination, medical expenses burden, living arrangement, smoking status, alcohol consumption, sleep duration, physical exercise, BMI, NCDs, self-reported health.

Figures

Figure 1

Standardized estimation of the relationship between ADL, social isolation(LSNS), Life satisfaction (SWLS) and MCI.

Supplementary Files

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- [Hypotheticalmodel.docx](#)