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Bidirectional relationship between cognitive function and loss hierarchy of activities of daily living among older adults with disabilities in urban China: a cross-lagged analysis

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ABSTRACT

Objectives The present study aimed to determine the bidirectional relationship between cognitive function and the loss hierarchy of activities of daily living (ADL) among older adults in China.

Design Data were derived from the Longitudinal Study on Family Caregivers for Frail Older Adults Aged 75 or Above in Shanghai (2010–2013).

Setting Community-dwelling older adults and their primary caregivers were invited to participate in this research.

Participants The inclusion criteria for the older adults were as follows: (a) have a Shanghai urban household registration status, (b) be 75 years old or older, (c) have no fewer than two limitations in ADLs or equivalent, and (d) have one primary caregiver aged 18 years or older. 469 older adults cared by their spouses or children were included in the final analytical sample of this research.

Primary and secondary outcome measures Cognitive function was assessed using the Chinese version of the Short Portable Mental Status Questionnaire and ADLs were measured by self-reports of having difficulty or needing help with basic daily activities.

Results Cognitive function in 2010 was a significant predictor of intermediate loss of ADLs in 2013 (β=−0.13, $p<0.05$) and late loss of ADLs in 2013 (β=−0.17, $p<0.01$). The loss hierarchy of ADLs among older adults was not shown to be significant as a risk factor of cognitive function in 2013.

Conclusions Practitioners are encouraged to adopt the ADL loss hierarchy as a supplementary needs assessment tool to make the social service delivery process more effective, economical and tailored. Cognitive function change monitoring programmes and services providing education on nutrition and encouraging social participation of older individuals were also helpful in promoting the quality of life of the older adults.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study is among the first to present local evidence on the bidirectional relationship between cognitive function and the hierarchy of activities of daily living loss among Chinese older adults with longitudinal data.
⇒ The cross-lagged model adopted in this research allowing for complicated testing over time in a single model.
⇒ Data from this study were convenient sample collected from six urban communities in Shanghai, which may constrain the generalisation of the proposed model and findings.

BACKGROUND

The prevalence of age-related health problems is becoming an important public health concern together with population ageing. One of the most important healthcare issues facing today's older population is cognitive impairment and its implications.[1] Cognitive impairment is a complex syndrome that would undermine activities of daily living (ADL) and quality of life.[2] Indeed, the prevalence of disability in basic ADLs, such as feeding, dressing and bathing, increases with advancing age as well.[3] In 2018, the WHO proposed to build a supportive environment to prevent decline in physical and cognitive function of the older adults and to further enhance the quality of their prolonged lives. Hence, understanding the factors that influence ADL disability and cognitive functions of older adults will contribute to future social policy and long-term care service planning.

An increasing number of studies indicated the relationship between cognitive function and ADL disability is complex and potentially bidirectional. On one hand, there were research findings that suggest cognitive dysfunction is a major risk factor associated with ADL disability.[4–7] On the other hand, it was observed that older individuals with ADL limitations were more likely to be diagnosed with dementia.[7–9] A meta-analysis indicated that it could be possible that ADL disability

and changes in cognitive function may, in part, share a common pathological basis.[10]

It could be inferred from the aforementioned research that ADL function loss and cognitive function may influence one another. However, previous studies have largely overlooked the potentially bidirectional relationship of cognitive function and ADL disability. Thus, it is not clear how these relationships exist dynamically over time, which limits the evidence available for making conclusions about these temporal associations. Therefore, examining the bidirectional relationship between cognitive function and late-life disability in basic ADLs would contribute to the further delineating of their relationship. To date, there is a little study testing the relationship between cognition function and ADL hierarchy which presented inconsistent conclusions.[11 12] Therefore, this study aimed to deepen the understanding on the relationship between the older individuals' cognitive function and the loss hierarchy of ADLs in urban China, which may expand the accumulated knowledge and help professionals determine future healthcare needs.

Hierarchy in functional decline of ADLs

Previous studies have shown that the physical function loss of ADL was hierarchical in nature[13–17] and can be formed as a pattern which would be helpful for monitoring ADL disability progression across episodes of care and predicting long-term care use among older adults who match the hierarchical loss pattern.[14 16 18] In some original research, it was indicated that among the ADL categories measured, participants on average lost the ability to bathe independently before losing their ability to dress, use the toilet, and transfer, continence and feeding.[19] In terms of older individuals with dementia, Giebel *et al*'s 2015 study found that bathing and dressing impairments were present in earlier stages, whereas impairment in toileting, ambulation and feeding was spared until the later stages. Comparative analysis was also conducted to examine the ADL loss hierarchy among older Americans and Chinese, which identified that bathing is the first activity that both older Americans and Chinese have difficulty with, while eating is the last activity. There are differences in the rank order for toileting (ranked more challenging in the Chinese sample) and dressing (ranked more challenging in the US sample).[16] However, in some medical studies, a common conclusion has been reached that older adults tend to lose ability in activities that require lower extremity strength (eg, walking) earlier than activities that require upper extremity strength (eg, eating).[20 21]

Although the reviewed literature indicated that the loss of ability to perform ADL tasks demonstrated hierarchical structures, the hierarchy in functional decline demonstrated mixed patterns across societies due to the different populations studied and different measurement adopted. Researchers had highlighted potential impacts of demographic factors and subpopulations on the changes of ADL function.[22] For instance, the loss of ADLs was assumed to demonstrate different patterns between the oldest-old group (above 80 years) and other older age groups (60–79 years).[3] Given the facts that the Chinese population is experiencing rapid ageing, ADL disability among the old-old group causes economic, family and social burden, information on the loss hierarchy in basic ADL disability and its relationship with cognitive function is relevant for policymakers. Therefore, in order to provide more appropriate evidence on context-sensitive policy and service design, there is a need to explore the ADL loss hierarchy among older adults especially among the old-old in Chinese communities.

The influence of cognitive function on ADL disability

The biopsychosocial model of the disablement process[23] may help to describe how cognition impairment leads to ADL limitations. According to this model, ADL disability is hypothesised to be an outcome based on physical and/or cognitive constraints as well as environmental barriers and/or psychological factors. For example, if older people are unable to bathe themselves independently (an ADL), it may be because of severe arthritis limiting hand movement (a physical impairment) or because of cognitive deficits restricting their ability to perform this task in sequence. Therefore, researchers suggested that regular screening of cognitive status is important to anticipate the potential onset of disability and delay this process where possible.[4]

Findings from cross-sectional studies across samples of older people with and without dementia have shown the association between the decline of cognitive function and ADL disability.[4 5] Especially in the middle and later dementia stages, the association between cognitive function and functional ability in ADLs becomes stronger.[24]

Furthermore, results from longitudinal research have demonstrated that cognitive impairment may precede ADL disability among older individuals.[25] In a 52-month study of functional decline in nursing home residents, researchers found that severe dementia predicted poorer ADL functioning.[6] Similarly, in a community-based longitudinal study, the main findings demonstrated that cognitive score predicted subsequent ADL disability in both older adults without dementia and patients with Alzheimer's disease.[26]

Although the cross-sectional studies mentioned above have shown that cognitive function is associated with older people's ADL function, and evidence from longitudinal research indicated that cognitive function was an important predictor of the older people's subsequent limitations in ADLs, it remains unclear whether this holds true for different stages of the ADL function loss process. As demonstrated in many studies, there is a hierarchical structure to the loss of basic ADLs.[15–17]

The effects of ADL disability on cognitive function

There are many cross-sectional studies observing the typical association of physical function and dementia that adopt ADL status as a diagnostic indicator of dementia.

Specifically, older individuals with ADL limitations were more likely to be diagnosed with dementia.[7–9]

Although longitudinal studies have provided some clues for understanding the dynamics of the relationship between physical and cognitive function of the older individuals, there is a lack of detailed information on the effects of ADL disability on cognitive function among Chinese older adults. A few studies indicated that individuals without dementia or preclinical dementia were first experiencing frailty, such as gait and balance impairment, being underweight and weaker grip strength,[27 28] or having limitations in the more complex instrumental ADL (IADL).[29] One possible explanation for this is that there is some specific pathology impacting physical function that exacerbates dementia progression. For instance, cognitive impairment may share neurological pathology with physical performance tasks.[30] Only limited research found that ADL disability was a significant predictor of dementia onset, after controlling for baseline cognitive function.[31]

The aforementioned findings have provided valuable clues for understanding how physical function relates to cognitive function among elder people. However, there is limited direct investigation examining the association between ADLs and cognitive impairment among older adults without dementia.[32] Although there were some studies indicating the association between IADLs (which require higher cognitive ability than ADLs) and cognitive impairment,[10 29] it could be possible that such relationship existed because essentially the pathology that eventually causes reduction in the cognitive abilities to complete IADLs may also cause the decline of cognitive status. A limited study which indicated that ADL was a risk predictor for dementia[31] failed to demonstrate whether different domains of ADL function loss carried comparable levels of risk to cognitive status because it only included ADL evaluations as a whole score in its research design. Thus, further studies need to be conducted to examine how changes in ADL loss predict cognition function. Demonstrating the relationship between cognitive function and changed need for ADL assistance is needed to help determine future healthcare needs.

Based on this overview, three research gaps were identified: (a) no local evidence has existed by exploring the relationship between the hierarchy of ADL function loss and cognitive function among Chinese older adults, especially the old-old who have more daily caring needs; (b) the stability of the relationship between cognitive function and ADL disability over time has not been ascertained, although there is general consensus that the loss of ADL is a process and demonstrated as hierarchical structure; (c) no research has explored the bidirectional relationship between ADL changes and measurable cognitive changes although previous research has shown that declines in ADL functions and cognitive functions are inter-related and influence one another.

The present study tried to fill the identified research gaps highlighted above by determining the bidirectional relationship between cognitive function and the loss hierarchy of ADLs among older adults aged 75 and above in China. By examining the bidirectional relationships between cognitive function and the loss hierarchy of ADL, the cognitive status of the baseline would be controlled, therefore providing clearer clues for understanding the stability of the relationship between cognitive functions and ADL disability over time. Moreover, by taking the structure of ADL loss hierarchy into consideration, it would help us to better understand the role that cognitive function may play in the stages of the ADL loss process. This would be useful at a practice level by determining eligibility for care services and predicting long-term care use among older adults.

METHODS

Participants

Data were derived from the Longitudinal Study on Family Caregivers for Frail Older Adults Aged 75 or Above in Shanghai. According to the latest national census of China, Shanghai is the metropolis having most serious older demographic composition. Older citizens account for 23.4% of their residents, with 4.68 percentage points higher than the national average.[33] This longitudinal research project aimed to explore long-term care needs and mental health of frail older adults and their family caregivers. The baseline study was conducted in 2010, and follow-up surveys were completed in 2013 and 2016.

Quota sampling was adopted to recruit community-dwelling older adults and their primary caregivers. The sampling procedures consisted of two steps. First, six urban districts were randomly selected from the 16 districts in Shanghai. Then, one street office from each of the six urban districts in Shanghai was randomly selected. Second, 120 older adult–caregiver dyads from each of the selected street offices were recruited (this study only included the information on the older adults in analysis). The inclusion criteria for the older adults were as follows: (a) have a Shanghai urban household registration status (to ensure the older participants were not migrant older adults), (b) be 75 years old or older, (c) have no fewer than two limitations in ADLs or equivalent, and (d) have one primary caregiver aged 18 years or older.

A total of 720 older adult–family caregiver dyads successfully completed the 2010 baseline survey, and 481 original older adult–caregiver dyads participated in the 2013 follow-up survey. Mortality is the main cause of sample attrition (22.8%). Compared with those who died during the survey time (2010–2013), the survivors reported fewer ADL limitations. This study only included information on ADL, cognition status and sociodemographic characteristics of the older adults in the analysis. Finally, 469 older adults cared for by their spouses or children were included in the final analytical sample.

Patient and public involvement

No patient was involved.

Measurement

ADL disability was measured by self-reports of having difficulty or needing help with basic daily activities.[34] The respondents were asked: 'Did you need help with the following basic daily activities in the past three months?', where these activities referred to walking, climbing stairs, feeding, dressing, hygiene, moving in and out of bed, bathing and using the toilet. The responses were assessed by a 3-point Likert scale (0=very difficult and fail to complete the task independently; 5=difficult and need others' assistance or using external devices; 10=not difficult and can complete the task independently). Lower ADL scores indicated more functional limitations in the respondents' daily lives. A sum score ranging from 0 to 20 indicates complete dependence; from 21 to 60 presents severe dependence; from 61 to 90 shows moderate dependence; from 91 to 99 indicates slight dependence; and 100 presents complete independence.[35] The reliability coefficient of these ADL items in terms of Cronbach's alpha is 0.83, indicating good consistency and reliability. Cognitive function was assessed using the Chinese version of the Short Portable Mental Status Questionnaire (SPMSQ).[36] The 10-item scale includes orientation, remote memory, personal history and calculation (Cronbach's alpha of the Chinese version of the SPMSQ was 0.83). The responses were assessed by a binary variable (0=correct; 1=incorrect). Summed scores were calculated to represent the cognitive levels of the respondents (range=0–10). Poor cognitive capacity would be identified with an SPMSQ score higher than 4 and those who received college education or higher with an SPMSQ score higher than 3.

Statistics analysis

Analysis proceeded in two steps. In the first analysis, the objective was to investigate the structure that would present early, intermediate and late loss of ADL function. We followed the approach proposed by Katz and his colleagues[13] to explore the ADL loss hierarchy. The basic structure was attained by examining which ADL function remained independent the longest as the older adults became less and less likely to maintain independence in any other areas of ADL function. Data used for the ADL loss hierarchy were derived from the 2013 wave.

Second, a two-wave cross-lagged model was conducted to investigate the bidirectional relationship between cognitive function and the hierarchy of ADL loss.

The cross-lagged model is a popular modelling strategy allowing for complicated testing over time in a single model. The model involves autoregressive and cross-lagged components which can identify reciprocal causal effects in non-experimental designs. The 'autoregressive' component means that the construct is regressed on earlier measures of itself, hence capturing and controlling for the stability of the construct itself, while the 'cross-lagged' component means that a construct is predicted by earlier measures of one or several other constructs.[37 38] This model has been widely used in psychological and geriatric research.[39–42]

The cross-lagged analysis proceeded as follows. First, measurement models of the hierarchy of ADL loss in the 2010 and 2013 waves were built separately through confirmatory factor analysis (CFA).[43] Then, the factor loadings of the latent constructs from the 2010 and 2013 waves were held equal to ensure that they represented the same latent construct across the two waves. We used change in CFA and χ^2 difference statistic to examine factor loading invariance (ie, a type of measurement invariance).[43–45] Lastly, bidirectional relationship between cognition and the hierarchy of ADL function loss was examined using the two-wave cross-lagged model. Variables of sociodemographic characteristics of the older adults (age, gender and marital status) at the baseline were controlled. The hypothesised relationships between six latent variables of the ADL function loss hierarchy, namely early loss in 2010 (including two observation variables of walking and stair climbing), intermediate loss in 2010 (including four observation variables of dressing, moving, bathing and toileting), late loss in 2010 (including two observation variables of feeding and hygiene), early loss in 2013 (including two observation variables of walking and stair climbing), intermediate loss in 2013 (including four observation variables of dressing, moving, bathing and toileting), late loss in 2013 (including two observation variables of feeding and hygiene), two observation variables of cognition status (cognition status in 2010, cognition status in 2013) and four control variables (age, gender, education and marital status), were examined. If a path from the hierarchy of ADL function loss in 2010 to cognition status in 2013 reaches significance ($p<0.05$), changes in the earlier hierarchy of ADL function loss are considered to lead to changes in the later cognition status. Similarly, if a path from cognition status in 2010 to the hierarchy of ADL function loss in 2013 reaches significance ($p<0.05$), changes in the earlier cognition status are considered to lead to changes in the later hierarchy of ADL function loss. There is no missingness in outcome variables (eg, ADL and cognition).

All analyses were performed using *Mplus* V.7. Maximum likelihood estimation was the default estimator. A series of fit indices were employed to indicate the model fit: the χ^2 test, comparative fit index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA) and standardised root mean square residual (SRMR).[35]

RESULTS

Demographic characteristics of the study sample

Demographic profiles of the study sample are shown in table 1. As at the 2010 baseline, the average age of subjects is 82.1. The majority of the older participants were female (62.5%) and married (53.7%). The mean scores of their cognition function were 2.3 (SD=2.1) in 2010 and 3.2(SD=2.2) in 2013, indicating good cognitive capacities of the sample. The mean ADL scores in 2010 and 2013 were 79.8 (SD=15.4) and 73.6 (SD=20.1), indicating

Table 1 Demographic characteristics of the study sample (n=469)

	n (%)	Mean (SD)
Age in 2010		82.1 (4.6)
Gender		
Female	293 (62.5)	
Marital status in 2010		
Married	252 (53.7)	
Other marital status	217 (46.3)	
Cognition status		
2010		2.3 (2.1)
2013		3.2 (2.2)
ADL in 2010		79.8 (15.4)
ADL in 2013		73.6 (20.1)

ADL, activities of daily living.

the prevalence of moderate dependence among older participants.

Hierarchical profile of ADL loss

This study tried to ascertain the basic structure of hierarchical function loss by examining which ADLs remained independent the longest as the total number of independent ADL function areas decreased. In table 2, the column headings represent the count of the number from 0 to 7 of the eight ADL areas in which the older adults maintained independence. The rows represent each of the individual ADL items. The values in the cells represent the number and percentage of persons who remained independent of ADL under the condition that there were only the indicated numbers of total areas (column headings) in which the participant was still independent. Taking the first row as an example, it demonstrated that there were 147 older adults independent of walking, and that among these participants, 87% still maintained independence in the other six to seven ADL areas (the total number of ADL areas measured in this research is 8). It could be inferred that an ADL function indicated in the rows would be the earlier loss function if most participants still can maintain independence in the other ADL areas. Otherwise, an ADL function indicated in the rows would be the later loss function as the total number of independent ADL function areas decreases. Bold data with underline in table 2 reflect where there is an indication that independence is lost as the number of total areas of independence decreases.

From these analyses of the hierarchy of ADL loss, we conclude that there are two early loss of ADLs (walking and stair climbing), four intermediate loss of ADLs (dressing, moving, bathing and toileting) and two late loss of ADLs (feeding and hygiene). Although there was some interindividual variation, this study further examined the proposed hierarchy by checking the model fit indices in the measurement model test process.

Cross-lagged model results

As demonstrated in figure 1, measurement models of the hierarchy of ADL loss based on the 2010 and 2013 waves were established before testing the cross-lagged model. CFA was used to examine the relationships between the factor indicators and the corresponding factors, including factor loadings, factor variance and correlations. Maximum likelihood estimation was the default estimation technique.

The latent construct of the hierarchy of ADL loss had three factor indicators: early loss, intermediate loss and late loss. The analytical procedures were as follows: in the first step, the measurement model of the ADL hierarchy was tested in the 2010 and 2013 waves separately. Both models showed good model fit (2010 wave: $\chi^2(14)=20.23$, p=0.12, RMSEA=0.03, CFI=1.00, TLI=0.99, SRMR=0.02; 2013 wave: $\chi^2(14)=22.75$, p=0.06, RMSEA=0.04, CFI=1.00,

Table 2 Hierarchical profile of the ADL loss

	Independent of: only 'independent (=10)'								
ADL area	0 ADL (%)	1 ADL (%)	2 ADLs (%)	3 ADLs (%)	4 ADLs (%)	5 ADLs (%)	6 ADLs (%)	7 ADLs (%)	Total
Walking	1 (0.7)	0 (0)	2 (1.4)	3 (2.0)	3 (2.0)	9 (6.1)	**30 (20.4)**	**99 (67.3)**	147
Stair climbing	0 (0)	0 (0)	0 (0)	0 (0)	1 (3.0)	0 (0)	**12 (36.4)**	**20 (60.6)**	33
Dressing	0 (0)	3 (1.0)	2 (0.7)	**12 (4.0)**	**33 (11.0)**	**47 (15.7)**	78 (26.1)	124 (41.5)	299
Moving	0 (0)	1 (0.4)	2 (0.8)	**10 (4.0)**	**26 (10.4)**	**33 (13.3)**	59 (23.7)	118 (47.4)	249
Bathing	0 (0)	0 (0)	0 (0)	**1 (1.3)**	**2 (2.6)**	**4 (5.1)**	24 (30.8)	47 (60.2)	78
Toilet	0 (0)	0 (0)	2 (0.7)	**11 (3.6)**	**35 (11.4)**	**53 (17.3)**	80 (26.1)	125 (40.8)	306
Hygiene	**0 (0)**	**5 (1.4)**	**7 (2.0)**	27 (7.5)	55 (15.4)	56 (15.6)	82 (22.9)	126 (35.2)	358
Feeding	**5 (1.3)**	**6 (1.6)**	**20 (5.2)**	34 (8.8)	54 (14.0)	58 (15.0)	83 (21.5)	126 (32.6)	386

Data were derived from the 2013 wave.
Bold data with underline reflect where there is an indication that independence is lost as the number of total areas of independence decreases.
ADL, activities of daily living.

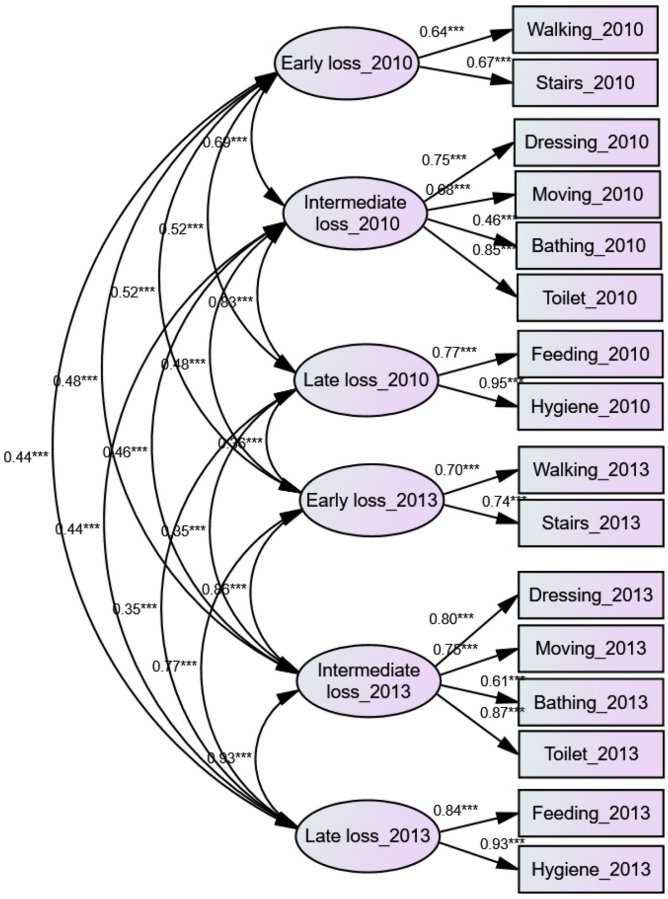

Figure 1 Measurement model of hierarchy of physical function loss. ***p<0.001 (two tailed).

TLI=0.99, SRMR=0.02). Second, we ran the measurement model of the ADL hierarchy in 2010 and 2013 in the same model, and allowed all the parameters to be freely estimated ($\chi^2(80)=104.370$, p=0.04, RMSEA=0.03, CFI=0.99, TLI=0.99, SRMR=0.03). Third, the factor loadings of the latent variables were held equal across the two waves. The model fit indices showed that the measurement models provided a good fit ($\chi^2(85)=107.12$, p=0.05, RMSEA=0.02, CFI=0.99, TLI=0.99, SRMR=0.04). After the factor loadings were held equal, the increase in the χ^2 estimates was statistically non-significant (change in χ^2 estimates(5)=2.75, p>0.05). Moreover, change in CFI was 0.00. This showed that the model fit did not become worse after we assumed factor loading invariance.[45] Furthermore, the standardised factor loadings of the five factor indicators ranged from 0.46 to 0.95 and were all statistically significant at the 0.001 level.

The results of the fit indices demonstrated adequate model fit for the cross-lagged model. $\chi^2(143)= 170.74$, p=0.06, RMSEA=0.02, CFI=0.99, TLI=0.99, SRMR=0.03. As demonstrated in figure 2, the cross-lagged model has shown that cognitive status in 2010 was a significant predictor of intermediate loss of ADLs in 2013 (β=−0.13, p<0.05) and late loss of ADLs in 2013 (β=−0.17, p<0.01). The hierarchy of ADL loss among frail older adults was not verified as a risk factor of cognitive status in 2013. The detailed autoregressive and cross-lagged effects for ADL loss hierarchy and cognition status were provided in online supplemental table 1.

We ran additional analyses by conducting cross-lagged analyses among older women (n=293) and men (n=176) separately. The results were similar to that of the original analysis. In the two subgroup analyses, cognitive function in 2010 was a significant predictor of late loss of ADLs (feeding and hygiene) in 2013 (women: β=−0.16, p<0.05; men: β=−0.19, p<0.01). Furthermore, the loss hierarchy of ADLs among older adults was not shown to be significant as a risk factor of cognitive function in 2013 among both gender groups, all p>0.05. However, cognitive function in 2010 was not a significant predictor of intermediate loss of ADLs (dressing, moving, bathing and toileting) in 2013 in both gender groups (women: β=−0.08, p=0.15; men: β=−0.16, p=0.08). This result is inconsistent with that of the whole sample. This might be because the sample sizes of the two gender groups are not large enough.

Furthermore, a series of linear regression models with interaction terms (eg, baseline cognitive function * gender) were conducted. All interaction terms were statistically non-significant, all p>0.05. This showed that the

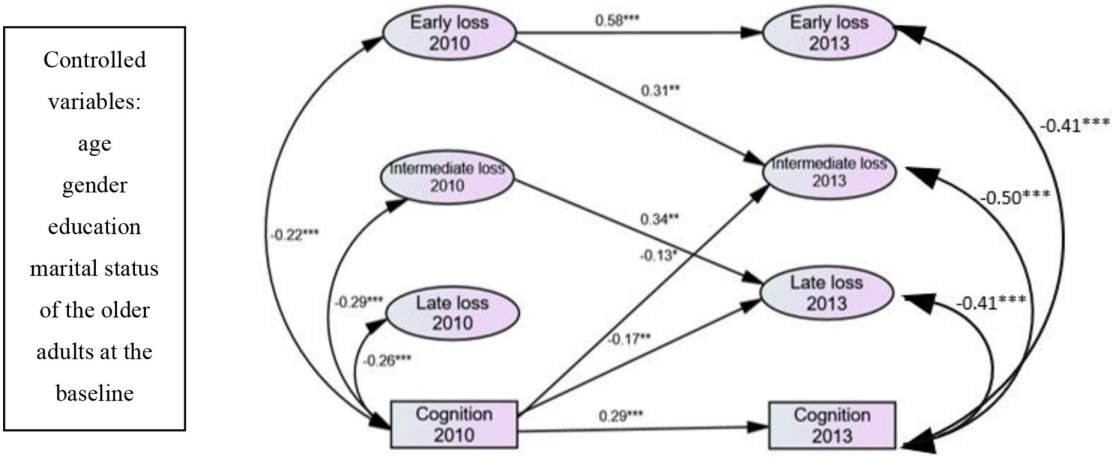

Figure 2 Cross-lagged model. *P<0.05 (two tailed); **p<0.01 (two tailed); ***p<0.001 (two tailed).

results did not differ between women and men. Finally, gender was controlled in the final cross-lagged analysis.

Finally, we acknowledged that the respondents were recruited from six streets in Shanghai. We conducted additional sensitivity analysis by conducting random-effects regression models to test whether the results were representative of the six streets. These models generated similar results.

DISCUSSION

This study is among the first to present local evidence on the bidirectional relationship between cognitive function and the hierarchy of ADL loss among Chinese older adults with longitudinal data. The integrated model of cognition and ADL loss hierarchy proposed by this research indicated that the baseline cognitive status was a significant predictor of the follow-up intermediate (dressing, moving, bathing and toileting) and late loss of ADLs (feeding and hygiene). Consistent with previous literature, the findings showed that the baseline cognitive status was significantly associated with subsequent ADL loss.[6 26] Although findings in this research only supported the biopsychosocial model of the disablement process,[23] it is worth stressing that this study made new contributions by simultaneously testing the reversed relationship and found that such relationship was statistically non-significant when baseline cognitive status was controlled in the model.

Our findings have also made contributions to the cumulative knowledge by stressing the influence of cognition function on ADLs holding stable within stages of the disability process. However, the findings showed that cognition function affects intermediate and late loss, rather than early loss. This might be partially due to the sampling inclusion criteria of older adults aged 75 years and older and having ADL limitations at baseline. In 2010, 68.4% and 90.0% of the respondents had difficulty in walking and climbing stairs, respectively. This could have led to the lack of variance in early loss of ADL. Future studies are needed to replicate the findings. In addition, cognition function is associated with age. The decline rates accelerate when older adults get older. In this case, it might mean that the majority of respondents would already have lost their walking/climbing stairs capacities when their cognitive functions start to decline. Moreover, the findings of this study did not identify significant sex differences in the hierarchy of ADL loss and cognitive function in both 2010 and 2013 waves. However, this might be partially due to mortality selection bias. As previously mentioned, the mortality rate of the sample was 22.8%, and only the survivors were included in the final analysis.

The findings of the present study have the following service promotion and intervention implications. First, the hierarchical loss pattern may have many applications, resulting in clinicians and social workers seeking less ambiguous guidance on what is happening to older adults. Instead of evaluating the ability to perform ADLs for older adults with a summed score, the ADL loss hierarchy could reveal more useful and detailed information and could differentiate the caring needs of older individuals. It could also help service planners anticipate the further caring needs of older adults and their family members. Therefore, we argued that adopting the ADL loss hierarchy as a supplementary needs assessment tool may make the social service delivery process more effective, economical and tailored. Second, based on the findings in the present research, cognitive function change monitoring programmes or services could be developed in community-based clinical service centres. These could be helpful in anticipating the potential onset of disability and, where possible, delay this process by providing relevant ADL function training services. Lastly, since cognitive status was a significant predictor of ADL loss, this indicated the necessity of developing interventions to stimulate and maintain older people's cognition status. Relevant services for providing education on nutrition and encouraging social participation of older individuals and their family caregivers could be developed in community-based environments.

Despite the merits of the present study, it has several limitations. First, data from this study were convenient sample collected from six urban communities in Shanghai, China. This may constrain the generalisation of the proposed model and findings. Future studies may need to verify the model in other contexts. Second, this study did not include variables of continence and bladder function because the aim of this study was to provide suggestions about ADL that caregivers and service providers could help with. To date, previous studies examining ADL loss hierarchy also barely took bladder and continence into consideration.[15–17] Future studies may take these two activities into consideration according to different research objectives. Another limitation is that the assessment of older adults' cognitive function relied on SPMSQ and ignoring the cognitive function loss hierarchy. Future studies are needed to take closer look at dementia population and to address the relationship between ADL loss hierarchy and cognitive function hierarchy. Finally, in this study, only older adults with two ADL limitations or equivalent were included in the final analysis. Therefore, the older respondents already had some decline in ADL when they participated in the survey. This might partially explain why cognitive function at baseline was not associated with early loss of ADL. Given that the proportion of older adults with ADL limitations is around 15% in Shanghai, future longitudinal studies (eg, three to four waves) are recommended to be conducted with larger sample sizes (eg, four to five times larger than this study, and including older adults without ADL limitations at baseline) to test the relationship between cognitive function and ADL loss hierarchy (especially early loss of ADL), and the potential sex differences in the ADL loss hierarchy.

CONCLUSION

In conclusion, by using a longitudinal data of individuals aged 75 years and above, this study fills the research gaps by describing the hierarchical loss patterns of ADL among old-old adults in Chinese communities, and demonstrating the cognitive function was a significant predictor of intermediate and late loss hierarchy of ADLs. With the process of ageing, this specific age group is at greater risk of unmet caring and medical needs due to the challenges they face in cognitive and ADL loss, their reliance on other for support and the barriers they face in maintaining community integration. Thus, evidence provided in the present study could potentially improve the quality of life of these persons and their caregivers and could play an important part in the healthcare planning process.

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