

RESEARCH ARTICLE

Association between cognitive functioning and active life engagement: A time-use study of older adults in rural China

Huijun Liu¹, Yaolin Pei^{2*}, Bei Wu²

¹School of Public Policy and Administration, Xi'an Jiaotong University, Xi'an, Shaanxi Province, China

²Rory Meyers College of Nursing, New York University, New York City, New York, USA

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*CORRESPONDING AUTHOR

Yaolin Pei,
New York University, Rory
Meyers College of Nursing,
433 First Avenue New York,
New York 10010, USA.
yp22@nyu.edu

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Abstract: This study aimed to examine the pattern of active life engagement and the association between cognitive functioning and active life engagement among older adults in rural China. Two waves of panel data with the previous day's activities in a time-use survey were collected among older adults age 60 and older in rural China. Logistic and OLS regressions were used to examine the impacts of cognitive functioning on participation and intensity in six types of activities. The overall active life engagement level of older adults in rural China was relatively low. Cognitive functioning and its decline significantly associated with the active life engagement. Older adults with higher cognitive functioning were more likely to engage in household work, recreational activity, and socially connected activity, and the decline in cognitive functioning was also significantly associated with the lower likelihood of engaging in household work, recreational activity, physical activity, and lower intensity of socially connected activity. Participation in diverse life activities is an important component of successful aging. The findings of this study suggest the need for increasing awareness of the influence of cognition on daily activities. Future interventions need to consider cognitive health to maximize active life engagement in Chinese rural older adults.

Keywords: Cognitive functioning; Decline; Time-use; Active life engagement; Successful aging

1. Introduction

Active life engagement which has been defined as having two major components “remaining involved in activities that are meaningful and purposeful” and “maintaining close relationships” (Rowe and Kahn, 1998) – is a useful umbrella under which to categorize productive activities, socially connected activity, recreational activity, and physical activity. Although opportunities for active life engagement may decline with age, continuing participation in diverse life activities is an important component of successful aging and can promote the health and well-being of older adults (Dong, Li, and Simon, 2014; Rowe and Kahn, 1997; Rowe and Kahn, 1998). However, the ability to perform daily activities such as cognitive functioning may determine the kind of activities that older adults can participate. Identifying which types of activities are mostly determined by the cognitive functioning is critical for interventions of promoting successful aging.

It is evident that active life engagement of older adults is constrained by their external environment and individual resources, such as facilities, age, and socioeconomic status,

as well as their own health conditions (Mejía, Ryan, Gonzalez, *et al.*, 2017). At the same time, although not inevitable, cognitive impairment become more common in late life. Therefore, in addition to improve active life engagement before the onset of functional decline, it is also important to promote active life engagement in the wake of impairments in cognitive functioning.

Maintaining active life engagement is a significant challenge in rural China, due to a lack of resources at individual and community level. This issue is exacerbated in the face of rapid increase of aging population in rural areas (Chen and Liu, 2009; Peng, 2011). The previous studies on this issue have mainly focuses on Western countries with cross-sectional designs, and little is known about the relationship between cognitive impairment and active life engagement among older adults in rural China. Furthermore, research on the influence of cognitive impairment on active life engagement is only limited among older adults with some chronic diseases (Ben Ari, Johansson, Ytterberg, *et al.*, 2014; Desrosiers, Demers, Robichaud, *et al.*, 2008; Lenze, Munin, Dew, *et al.*, 2004).

Diary-based methods that capture individuals' time-use for a single day allows researchers to detail the participation of daily activities that are comprised active life engagement and address the limitations of the previous studies that used aggregated measures of time-use (Freedman, Cornman, Carr, *et al.*, 2019; McKenna, Liddle, Brown, *et al.*, 2009). Using this approach, each participant is asked to recall what he/she was doing on the previous day, specific activities are clearly outlined and participation in daily activities can be distinguished. In addition, time-use diaries are less likely to be influenced by biases related to social desirability and are more accurate and precise than aggregated measures (e.g., general survey questions) in understanding the daily life of participants (Brenner, 2011; Sabbath, Matz-Costa, Rowe, *et al.*, 2016).

Using a two-wave representative sample of older adults in rural China, the purpose of this study is to examine the pattern of active life engagement among rural Chinese older adults and investigate the impact of level and declines of cognitive functioning on different kinds of activities.

1.1. The rural China setting

Rural older Chinese population represent a unique opportunity for studying the relationship between cognitive functioning and active life engagement. The majority of rural Chinese older adults may have to make a living by participating in the paid work beyond age 65 and until their health deteriorates, due to the out-migration of their adult children, and a lack of comprehensive social security system (Zhang, 2010; Zhou, 2012). In addition, due to significant rural-urban disparities in socioeconomic development, rural villages are less likely to have cultural, wellness and recreational facilities (e.g., senior activity centers and chess room) than communities in urban areas (Liu, 2016). Moreover, rural Chinese older adults are less likely to participate in volunteering activities compared to urban China, because most volunteer programs in China are organized by government agencies and mainly targeted to retired professionals (Luo, Pan, and Zhang, 2019).

1.2. Cognitive functioning and active life engagement

The International Classification of Functioning, Disability and Health Model (ICF model) developed by the World Health Organization, provides a relevant conceptual framework for studying the association between functional ability and active life engagement in older adults (the World Health Organization, 2001). The phenomenon of participation in activities not only is related to impairments but also links to the environment individuals reside (Arnadottir, Gunnarsdottir, Stenlund, *et al.*, 2011). According to this model, active life engagement is constrained by cognitive functioning, as well as contextual factors that include personal (e.g., age and gender) and external environmental factors (e.g., region). The ICF Model has been widely used by rehabilitation researchers to identify risk factors (e.g., vision, physical functioning, and cognitive functioning) for active life engagement and evaluate rehabilitation success after their therapeutic interventions among older adults with chronic diseases (Alma, Van der Mei, Melis-Dankers, *et al.*, 2011; Anaby, Miller, Eng, *et al.*, 2009; Ben Ari, Johansson, Ytterberg, *et al.*, 2014; Cimarolli, Boerner, Reinhardt, *et al.*, 2017; Desrosiers, Demers, Robichaud, *et al.*, 2008; Lenze, Munin, Dew, *et al.*, 2004). It is noted that the ICF model could be applied to general populations of older adults, not only those with impairments or chronic disease (Levasseur, Desrosiers, and Tribble, 2007).

Cognitive impairment may limit everyday activities in older adults. For those rural Chinese older adults, withdrawal from economy activities and social activities is generally not voluntary but due to the decline of physical and cognitive functioning (Arnadottir, Gunnarsdottir, Stenlund, *et al.*, 2011; Rosso, Taylor, Tabb, *et al.*, 2013). However, there is limited research on the association between cognitive functioning and active life engagement among rural older adults in China.

Impairments in cognitive functioning may decrease rural older adults' ability to participate in economic and physical activities that need considerable motor skills and function in decision making. Some evidence shows that health status is

associated with paid work participation, but is not associated with other activities (Sabbath, Matz-Costa, Rowe, *et al.*, 2016). Severe levels of limitations in cognitive functioning may also influence participation in activities that need some cognitive reserves, such as household work, caregiving activities, and socially connected activity. For example, individuals with possible and probable dementia were less likely to engage in social connecting activities (Parisi, Roberts, Szanton, *et al.*, 2017).

Among older adults who have hip fracture, cognitive impairment is associated with less exercises (Lenze, Munin, Dew, *et al.*, 2004). In a study that included adults with multiple sclerosis, cognitive impairment was associated with restrictions in participations in domestic, leisure, and mobility activities (Ben Ari, Johansson, Ytterberg, *et al.*, 2014). While these studies were conducted in outpatient clinics and hospitals, limited studies have focused on community-dwelling older adults. More recently, in a systematic review and meta-analysis, Stolwyk *et al.*, (2021) and his colleagues found that the decline of cognitive functioning is associated with reduced active life engagement (Stolwyk, Mihaljevic, Wong, *et al.*, 2021). Therefore, we expect that low level cognitive functioning and its decline are associated with low levels of active life engagement among older adults in rural China.

2. Data and Methods

2.1. Data collection

Data were drawn from the longitudinal study on “Well-being of Elderly Survey in Anhui Province (WESAP),” a panel survey conducted every 3 years between 2001 and 2018 in rural townships of Chaohu, Anhui province. A total of seven waves of surveys were completed by trained interviewers. Using a stratified multistage sampling design, 1800 older adults aged 60 and older from 72 randomly selected villages within six rural townships were interviewed in the first wave in 2001 and 1715 provided valid information. The number of original respondents who participated in the follow-up surveys in 2003, 2006, 2009, and 2012 was 1391, 1067, 807, and 605, respectively. To replace the deceased and lost to follow-up elders, the 2009 and 2015 surveys also randomly recruited 420 (aged 60–68) and 480 (aged 60–65) refreshment cohorts from the same villages using the same sampling design.

This study focused on respondents who participated in the sixth (2015) and the seventh (2018) waves of the survey. The sixth wave served as the baseline in the current analysis, because it was the first time that the time-use diary data were specifically collected in the WESAP questionnaire survey. Pooling data from Wave 6 and 7 allowed us to examine, whether the baseline cognitive functioning and its decline were associated with time-use patterns 3 years later. Our sample consists of 1243 older adults age 60 and older who were interviewed in 2015. After removing 128 respondents who died before the 2018 survey, 95 who were lost to follow-up in 2018, and five cases with missing values in daily time-use and functioning, a total of 1015 older adults were included in this study. Compared with the excluded samples, the included ones were younger, more likely to be married and living with others, with higher income and more social support.

2.2. Measures

2.2.1. Outcome: Time-use on daily activities

The pattern of time-use which reflects active life engagement of older adults was assessed by a comprehensive 24-h recall measure. Following the general time-use data collection guidelines, this instrument was developed for participants' time used during the day before the date of survey completion. Investigators applied this time-use instrument to calculate the amount of time spent on each activity from a list of 17 items, such as housekeeping, caregiving, working at home, working away from home, leisure time, and sleep. To explore how the functional health of older adults specifically influence different domains of their active life engagement in a rural China's social setting, we grouped activity items into the following five categories: economic work (i.e., paid work and earning money from farming, business, manufacturing), household work (i.e., the activities for household maintenance such as cooking, cleaning, doing laundry, and caregiving activities to grandchildren, parents, or spouse), recreational activities (i.e., watching television/movie, reading books/newspapers, listening to the radio, and surfing the internet), physical activities (i.e., sports, walking, or dancing), and socially connected activities (i.e., making phone calls, chatting, and playing chess). Sedentary time for rest (e.g., napping or doze off) was also included as a reversed measure of active life engagement. These groupings distinguished the two dimensions of daily activities (social vs. solitary and active vs. sedentary) based on prior studies of time-use among older adults and the active engagement literature (Lee, Chi, and Palinkas, 2019; Lennartsson and Silverstein, 2001; Simone and Haas, 2013). Following the two-dimension measure of daily activities, the more time spent on both social and active activities (e.g., economic work), social activities (e.g., social connected activities), or active activities (e.g., physical activities), the less time spent on both solitary and sedentary activities

(e.g., sedentary time), and the more active life engagement is. In our study, the diary measure of time-use may not add up to 24 h, because some categories of time-use including volunteering that rarely happened in rural China and personal care activities such as sleeping, bathing, or eating at home were not considered in this study.

The amount of time spent on the activities of each category was calculated. For each activity, we measured with both participation and intensity (or daily duration of participation). Participation was assessed by a binary indicator of whether an individual participated in a given activity. For the subset who participated, the number of hours spent on that activity was used to assess intensity. We, then, grouped activities into the six broad categories of the interest for the current study and recalculated these measures.

2.2.2. Key predictors: Cognitive functioning

Cognitive functioning was considered as the key predictors of active life engagement in this study, which was measured both at the baseline level and its decline in follow-up.

The level of cognitive functioning was measured with the Chinese version of the Mini-Mental State Examination (MMSE). The MMSE mainly focuses on four dimensions of cognitive functioning: orientation, calculation, language or comprehension, and recall (Folstein, Folstein, and McHugh, 1975). In the Chinese version, we, further, modified some items according to the rural Chinese cultural and socioeconomic conditions, to improve the validity and the reliability of the scale implemented in the rural Chinese population. For example, the participants were asked to write a sentence, which is impossible for illiterate older adults to complete. We had to drop this item. The modified Chinese version of MMSE reached a high reliability in this study (cronbach's $\alpha = 0.85$). The combined score of MMSE ranges from 0 to 24, with higher scores indicating better cognitive functioning. The decline of cognitive functioning was coded as 1 if the score of cognitive function in 2018 is lower than that in 2015, otherwise was coded as 0.

2.2.3. Confounders: Sociodemographic variables and physical health

The sociodemographic variables of age, gender, marital status, education, and household income, which had been identified as important factors of health and time-use of older people, were controlled in the data analysis. We included age as a continuous variable and gender as a dichotomous variable (male = 1). Marital status was coded as married/living with partner as 1 and 0 as otherwise. Educational attainment was constructed as a dichotomous variable: "illiterate" or "literate" (primary school or above). Household income was assessed by the total amount of earnings of the individual and his/her spouse in the previous 12 months, including pensions, part-time income, and earnings from self-employed activities. It was transformed using in form in regression models.

We also included living arrangement, social support, presence of chronic disease(s), and Activities of Daily Life (ADLs) as potential confounders. Living arrangement was coded as a dichotomous variable (living alone = 1 and others = 0). Social support was measured by three indicators (continuous variables). The first one asked respondent "how many relatives and friends are contacted at least once within 1 month." The second one asked respondent "how many relatives and friends that you feel safe to discuss personal issues are there." The third one asked respondent "how many relatives and friends that you can look for help are there." Three dichotomous variables were used to indicate the presence of each of the following chronic diseases: diabetes, hypertension, and cardiovascular disease (heart disease or stroke). ADLs were assessed through a series of questions about activities of daily living and instrumental activities of daily living (ranges from 15 to 45), with a higher score indicating the older person exhibits better capability of performing these activities.

2.3. Analytical methodology

This study adopted both univariate and multivariate analyses of our two-wave panel data. Descriptive statistics were presented to summarize sample characteristics, cognitive functioning, and the time-use pattern. We also conducted two sets of analyses to examine the impacts of cognitive functioning level in 2015 and its decline on the likelihood and the intensity of participating different activities in 2018. According to the two measures of each activity, we first run logistic regressions to model the impacts of cognitive functioning level in 2015 and its decline on probability of participating in these activities or prevalence of participation in 2018. Then, we applied OLS regressions among participants to model the intensity (or daily duration) of participating in each category of activities, which given that our outcome was a count of the number of hours spent. All models were adjusted for potential confounders including sociodemographic characteristics, living arrangement, social support, presence of chronic disease, ADLs in 2015, and respective activities in 2015. In addition, normal test showed that the distributions of hours spent in six activities were skewed. Ln format was used to transform the dependent variables in OLS regression. All analyses were conducted using Stata 15 software.

3. Results

The characteristics of the sample in 2015 and functional health of sampled older adults are shown in Table 1. The average age of the sampled older men and women was 70 years old (range between 60 and 98), with over 70% married and 51% male. <40% respondents were literate. On average, the annual income of sampled household was about 6640 Yuan (Chinese Currency, equivalent to \$980) and 20% of the respondents lived alone. In terms of the presence of chronic disease, about 9% of the respondents had diabetes, almost 40% had hypertension, and over 20% had cardiovascular disease. Table 1 also presents the cognitive functioning (level in 2015 and decline in follow-up) of sampled older men and women. On average, almost half of the respondents reported a decline in their cognitive functioning.

Table 2 shows the pattern of active life engagement in 2018 among older adults in rural China. In 2018, about 56% of respondents reported that they were engaged in economic work and generally worked approximately 4 h; household work was performed by 75% of respondents; over 72% were engaged in recreational activity but only 37% performed physical activity; less than half (46%) participated in socially connected activity; and 88% of respondents spent 5 h on average for sedentary time.

Table 3 presents results of logistic regression for engagement of six types of activities after controlling engagement of six types of activities at baseline, respectively, socialdemographic characteristics, and physical health in 2015. Estimates suggest that older adults with higher level of cognitive functioning were more likely to engaging in household work, recreational activity, and social connected activity. The association between cognitive functioning and engagement of physical activity was also significant at marginal level (10%). Maintaining their cognitive functioning without decline was also significantly associated with higher possibility of engaging in household work, recreational activity, and physical

Table 1. Sample characteristics in 2015 and cognitive functioning

Variables	Mean (SE)/%	Coding/ranging
Gender	50.84	0=women; 1=men
Age	70.05 (7.77)	60–98
Marital status	72.65	0=single; 1=married
Education attainment	36.67	0=illiterate; 1=literate
Annual income	6639.54 (9243.69)	0–100000
Living arrangement	20.00	0=living with others; 1=living alone
Social support 1	3.19 (0.07)	0–10
Social support 2	2.88 (0.07)	0–9
Social support 3	3.43 (0.08)	0–10
Having diabetes	8.63	0=no; 1=onset
Having hypertension	38.73	0=no; 1=onset
Having cardiovascular disease	21.18	0=no; 1=onset
ADLs	41.77 (5.46)	15–45
Cognitive functioning in 2015	15.74 (4.83)	0–24
Cognitive functioning decline in 2018	47.59	0=no; 1=yes

Table 2. Time spent on daily activities among older adults in rural China in 2018

Activities	Percentage	Hours/mean (SD)
Economic work	56.29	4.17 (4.81)
Household work	75.25	4.06 (4.42)
Recreational activities	72.89	3.18 (3.49)
Physical activities	37.43	1.04 (2.24)
Socially connected activity	45.97	2.35 (3.31)
Sedentary time	88.31	5.11 (3.82)

Table 3. Estimates of logistic regression for engagement of six types of activities in 2018 ($n=1015$)

Variables	Economic work	Household work	Recreational activity	Physical activity	Sedentary time	Social connection
Engagement of activities in 2015	2.03***	2.17***	2.21***	2.05***	1.36	1.99***
Gender (Women for reference)	1.42*	0.18***	1.36 ⁺	1.01	1.15	0.84
Age	0.93***	0.97*	1.00	1.00	0.99	1.02*
Marital status (Single for reference)	1.15	0.68	0.75	0.82	0.80	1.07
Education (Illiterate for reference)	0.92	1.00	1.21	0.95	0.97	0.91
Annual income	1.13*	0.99	1.08	0.95	0.96	0.88*
Living alone	0.75	1.24	0.73	0.94	0.70	1.49 ⁺
Social support 1	0.95	0.98	0.97	1.06	0.95	0.99
Social support 2	1.04	0.95	0.97	1.02	1.08	0.97
Social support 3	0.98	1.01	1.06	0.96	0.89*	0.97
Having diabetes	1.46	1.59	1.49	1.22	0.94	1.54 ⁺
Having hypertension	0.86	1.03	0.95	1.33*	0.95	1.16
Having cardiovascular disease	1.11	0.93	1.04	1.26	0.89	0.88
ADLs	1.09***	1.06***	1.02	1.04*	0.99	1.04*
Cognitive function	1.02	1.09***	1.08***	1.03 ⁺	0.96	1.06**
Cognitive decline	0.81	0.66*	0.56***	0.73*	1.44 ⁺	1.00
Constant	0.74	1.45	0.15	0.07*	88.73*	0.03**
LR Chi2	271.04	182.40	116.00	57.67	18.20	78.14
Pseudo R2	0.1949	0.1606	0.0978	0.0430	0.0248	0.0558

Significance levels: ⁺ $P < 0.1$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

activity. However, decline of cognitive functioning in follow-up also increased the possibility of sedentary time at marginal level.

Only among the subsets who participated in each of the six types of activities in 2018 (duration hours >0), we run the OLS regression models to examine the impacts of cognitive functioning level in 2015 and its decline on intensity of participating six types of activities, respectively. The estimates of OLS regression after controlling participating intensity of six types of activities at baseline (including duration hours = 0), respectively, socialdemographic characteristics, and physical health are as shown in Table 4. The level of cognitive functioning was not significantly correlated to participating intensity of any of the six types of activity besides that the association between cognitive functioning and intensity of social connected activity was significant at 10% level. Cognitive functioning decline in follow-up only significantly reduced the frequency of participating social connected activity.

4. Discussion

Active life engagement has been identified as a critical indicator of successful aging. The study examined the patterns of time-use in older adults of rural China using the two waves of time diary data from rural China. On an absolute level, participants had low levels of active life engagement with more than 70% of rural older adults participating in sedentary recreational activities, 88% spending 5 h on average for sedentary time. Only 38% and 46% engaged in physical activity and socially connected activity, respectively. The impacts of cognitive functioning on probability and intensity of active life engagement varied by activities' type. After controlling baseline participation or intensity of activities, respectively, socialdemographic characteristics and physical health, cognitive functioning, and its decline significantly associated with house work, recreational activity, physical activity, and socially connected activity. These findings highlight the importance of promoting cognitive functioning to facilitate the active life engagement.

Consistent with some previous studies (Chou, Chow, and Chi, 2004; Dong, Li, and Simon, 2014; Gauthier and Smeeding, 2003), we found that the majority of older adults (over 70%) in rural China averagely spend more than 3 h

Table 4. Estimates of OLS regression for intensity of six types of activities in 2018

Variables	Economic work	Household work	Recreational activity	Physical activity	Sedentary time	Social connection
Intensity of activities in 2015	0.16***	0.07 ⁺	0.17***	0.08	0.12**	0.07 ⁺
Gender (Women for reference)	0.05	-0.46***	0.13*	0.07	-0.01	-0.08
Age	-0.03***	0.01 ⁺	0.01 ⁺	0.00	0.01**	0.01**
Marital status (Single for reference)	0.11	0.14 ⁺	0.08	-0.03	0.12 ⁺	-0.00
Education (Illiterate for reference)	0.08	-0.06	0.07	-0.19*	-0.00	0.06
Annual income	0.01	0.02	-0.04*	-0.05	-0.01	-0.04*
Living alone	-0.10	-0.04	0.11	-0.07	0.11 ⁺	0.13
Social support 1	-0.01	0.00	-0.01	0.00	-0.03**	-0.02
Social support 2	0.02	0.01	-0.01	-0.00	0.01	-0.00
Social support 3	-0.01	-0.01	0.01	-0.01	-0.01	-0.00
Having diabetes	0.10	-0.06	0.03	-0.02	0.07	-0.10
Having hypertension	-0.06	0.07	0.04	0.03	-0.02	0.11 ⁺
Having cardiovascular disease	-0.05	0.07	0.06	-0.02	0.04	-0.01
ADLs	0.01 ⁺	0.01	0.00	-0.01	-0.02***	0.01
Cognitive function	-0.01	0.00	-0.00	0.01	-0.01	0.01 ⁺
Cognitive decline	0.02	-0.03	-0.06	-0.01	0.04	-0.14*
Constant	2.97***	0.54	0.97*	1.27*	1.94***	0.72
F	11.84	7.78	3.59	0.46	8.11	2.30
R square	0.2544	0.1428	0.0736	0.0422	0.1286	0.0756
N	572	764	740	380	896	468

Significance levels: ⁺ $P < 0.1$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

in sedentary recreational activities (such as watching TV and reading or listening to radio) or just in sedentary time for rest (such as napping or doze off). Only about one third and 45% of respondents engaged in physical activity and socially connected activity, respectively. However, more than half of rural Chinese older adults still averagely spent 4 h on economic work. The previous studies suggested that the majority of rural Chinese older adults may need to participate in economic activities until their health deteriorates due to the lack of financial security (Zhang, 2010; Zhou, 2012). In a systematic review, estimated sedentary time which include sitting time and sedentary recreational activities, is half of that measured objectively (Harvey, Chastin, and Skelton, 2015). The self-reported dairy data in this study may underestimate the actual time in sedentary time. Overall, the participants exhibited low levels of active life engagement.

The present study found that lower level of cognitive functioning and its decline was associated with lower likelihood of engaging in many activities, such as household work, recreational activity, physical activity, and socially connected activity, and associated with a lower intensity of socially connected activity among Chinese older adults. Our study extends the previous findings on the association between cognitive functioning and active life engagement from those with impairments or chronic disease to general community-dwelling older adults. In addition, in line with previous evidence that limitations in physical functioning predicted lower participation across domains of leisure activities (Janke, Davey, and Kleiber, 2006) and a decline in functional capacity was associated with lower rates or ceasing of participation in some leisure activities and social connecting (Janke, Davey, and Kleiber, 2006; Lefrancois, Leclerc, and Poulin, 1997; Strain, Grabusic, Searle, *et al.*, 2002). Our study provide evidence that cognitive functioning is also a significant factor that affects individual's time-use pattern or life engaging behaviors in rural China.

Acting as a basic function or ability for maintaining personal autonomy and independence, cognitive functioning is a precondition for older adults to actively participate in most categories of physical, productive, or social-engaged activities. The significant effects of cognitive functioning on household work, recreational activity, and socially

connected activity suggest that a threshold in cognitive ability is required for some kinds of activities, which are usually less physical demanding but need more skills in comprehension, decision-making, and organizing. More importantly, though our findings are consistent with previous studies that cognitive functioning is positively associated with frequency of reading newspapers, books, and magazine (Chou, Chow, and Chi, 2004), we found that both cognitive functioning and cognitive decline were not associated with more likelihood of spending time idling or doing nothing (sedentary time). This implies that the higher percentage and intensity among older adults in rural China who spent in sedentary time are not caused by their limited cognitive functioning, but may due to a lack of resources in individuals and the region of rural China. According to the IFM model, in addition to functioning ability, active life engagement is also constrained by external resources (the World Health Organization, 2001). It is highly possible that poor resource in those rural Chinese older adults make them have few choices, but to participate in sedentary time. Another possibility is that older adults in rural China does not have positive life style due to their low levels of education.

5. Strengthens and Limitations

An important strength of this study is that a 24-h recall time diary was used to collect participants' time-use on all types of activities, which was considered to be more precise and accurate than the questions on time spent collected from general social surveys or stylized retrospective studies (Brenner, 2011; Sabbath, Matz-Costa, Rowe, *et al.*, 2016; Ver Ploeg, Altonji, Bradburn, *et al.*, 2000). In addition, the data used in this study come from a seven-wave longitudinal survey which has overall high participation level (over 95% responded to the survey) and low rate of lost follow-up (<8%). Our cohort study with the latest two-wave data allowed us to examine the association between changes of functional health and life engagement. Furthermore, because the baseline functional ability was measured before the collection of the study outcomes, this survey data enables us to examine whether cognitive functioning could predict older adults' active life engagement in later time.

However, we need to acknowledge several limitations in this study. First, functional health status is very likely to be both a precursor and a product of healthy time-use, creating a cycle of advantage or disadvantage (Aartsen, Smits, Van Tilburg, *et al.*, 2002; Schooler and Mulatu, 2001). The present study only examined the impacts of functional status at baseline and its decline on life engagements in follow-up by controlling the baseline time-use. We will examine the potential reciprocal relationship between functional health and life engagement in the future. Future research should also explore the causal relationship between cognitive decline trajectories and time-use pattern. A second limitation stems from the fact that our data come from a well-defined area of central China, which is thought to largely reflect the social and cultural conditions of poor rural areas. The study findings may not be generalizable to older adults in other rural areas of China. A third limitation is that the six categories of activities are grouped based on the social context of rural China and some activities such as volunteer work (which was considered an important indicator of social engagement) were not considered due to very low participation rate. Therefore, we were not able to examine the association between functional health and volunteering. In addition, one inevitable limitation of longitudinal research is attrition and the self-selection of participants over time. The individuals who dropped out of the study were more vulnerable than those included in our analyses. The excluded sample may have underestimated the effect of cognitive functioning on the life engagement of older parents. Finally, the R square in some of our regression models was very low which may be attributed to the miss of some key variables. Those key variables for engagement of physical activity and sedentary time should be explored in future study.

6. Conclusions

This study shows the overall low levels of active life engagement among older adults in rural China. Cognitive functioning and its decline impact the pattern of active life engagement among older people in rural China, which suggests that the active life engagement of older adults was limited by their declining cognitive functioning. However, their associations with different types of activities were less consistent. The findings of this study suggest the need for increasing awareness of the influence of cognition on daily activities. The early detection of cognitive impairment presents a good opportunity for interventions to maintain older adults' cognitive functioning in rural China. Given that active life engagement is critical to improve healthy life expectancy and the quality of life in older adults, it is important to increase their positive engagement. For example, we did not find the effect of cognitive functioning on

sedentary time. Future programs in rural China need to enrich the daily activities based on their cognitive functioning among older adults.

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Conflicts of Interest

The Author(s) declare(s) that there is no conflicts of interest.

Authors' Contributions

All authors participated in (a) the study conception and design, or the analysis and interpretation of data, (b) the drafting of the article or its critical revision for important intellectual content, and/or (c) approval of the version to be published.

Availability of Supporting Data

The data used in this study is not available for the public yet.

Ethics Statement

Ethical approval was obtained from the Ethical Review Committee of Xi'an Jiaotong University.

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