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A Longitudinal Study of Changes in Cognition Among Older Thais: Studying From the Kanchanaburi Demographic Surveillance System

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Abstract

Objectives: To examine the impacts of changes in social determinants of health (SDH) toward changes in cognition. **Methods:** Longitudinal data came from the Kanchanaburi Demographic Surveillance System (KDSS) collected in 2007 and 2011. Cognitive impairment was measured by category fluency and delayed recall. Generalized estimating equation (GEE) was used to investigate changes in cognition by taking SDH and other variables including age, gender, marital status, education, and depression into the model. **Results:** GEE revealed longitudinal effects of wealth index and working status against cognition. Older Thais living with richest wealth index (odds ratio [OR] = 0.54; 95% confidence interval [CI] = 0.31-0.94) and still being employed (OR = 0.65; 95% CI = 0.47-0.89) were less likely to have cognitive impairment. **Discussion:** Poorer wealth index and being unemployed were served as a risk factor for cognitive impairment over time. Increasing age was still the major risk for cognitive impairment.

Keywords

changes in cognition, cognitive impairment, older people, KDSS, longitudinal study

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Introduction

Thailand is experiencing the aging of the population, as are most countries around the world. Not all of older people experience healthy living in their sunset years. Increased longevity may increase risk of chronic conditions in older people. Older Thais might be living longer but they were not necessarily living in a healthy condition (Apinonkul, 2015). The common issue in older people is related to cognitive problems such as cognitive impairment and dementia. Although dementia commonly affects the older people, it is not a normal part of aging. Significantly, people with dementia often have a comorbid health condition such as diabetes or stroke (Bunn et al., 2014). Approximately 80% to 90% of people with dementia suffer from depression, anxiety, psychosis, aggression, disinhibition, and sleep disturbances (Muller-Spahn, 2003).

One major influence of cognitive problems is age. Older age was associated with lower scores on cognitive performance (Brewster et al., 2014; Karlamangla et al., 2009; Li, Ding, Wu, & Dong, 2017). Moreover, gender differences (Li et al., 2017; Zaninotto, Batty, Allerhand, & Deary, 2018), marital status (Karlamangla et al., 2009), educational level (Brewster et al., 2014; Parisi et al., 2011), and depression (Allerhand, Gale, & Deary, 2014; Köhler et al., 2010) were also found to be significantly associated with cognitive change over time. Social, economic, and environmental factors, recognized as social determinants of health (SDH), also have an important impact on cognition. Older people living with others had a higher risk of cognitive impairment than older people living alone (Zhou et al., 2018). There was some evidence showing that social and labor force participation could be an important factor for preserving cognitive abilities in older people (Bonsang, Adam, & Perelman, 2012; Bourassa, Memel, Woolverton, & Sbarra, 2017). Socioeconomic status (SES) is an important predictor of

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neurocognitive performance (Hackman & Farah, 2009). Several studies found the effects of poverty on cognitive abilities (Leonard, Mackey, Finn, & Gabrieli, 2015; Mani, Mullainathan, Shafir, & Zhao, 2013). In sum, previous studies showed significant effects of factors such as demographic characteristics and social, economic, and environmental characteristics toward health conditions of older people. Age, gender, education, SES, income, social support, and depression are related to health status of older people.

Longitudinal studies related to change in cognition are rarely done in Thailand. Although a cross-sectional study can provide an understanding about health conditions of older people, the patterns of change in health conditions might not be explained by using a cross-sectional design. According to several cross-sectional studies among older people within the Thai context, methodologies, characteristics of the samples, and results were variable and inconsistent. Therefore, it may be difficult to draw clear conclusions when applying results from cross-sectional studies. Thus, the questions about how cognition changes over time and what factors predict cognitive change are still unknown. Several studies have suggested the need for studies of health conditions related to quality living among older Thais within the Thai cultural and social context. In addition, there should also be ongoing studies to analyze the change in quality of life and to provide more insight into cause-and-effect relationships at different points in time (Jitprasert, 2005; Somrongthong et al., 2013; Suttajit et al., 2010; Wongpanarak & Chaleoykitti, 2014). A longitudinal study for an aging population would be of benefit for policy makers to help sharpen the focus on variables that have an impact on changes in the health conditions of older people.

One approach used for studying population change is to apply the Demographic Surveillance System (DSS). The DSS is a continuous process of defining risk and corresponding dynamics in the context of population change including births, deaths, migration, and other specific interests (Baiden, Hodgson, & Binka, 2006). A local source of data for studying Thai population health over time is the Kanchanaburi Demographic Surveillance System (KDSS). This study aimed to offer a clearer explanation about the effect of health determinants that influence cognition among older Thais over time. The results of this study should contribute to the design of effective interventions for promoting quality living and preventing inequity in health among older people.

Method

The KDSS

This study obtained secondary data from the KDSS which was initiated by the Institute for Population and Social Research (IPSR), Mahidol University, with support from the Wellcome Trust. The KDSS was performed in Kanchanaburi Province which is the country's third largest province, located in the west of Thailand and containing a variety of topography, population groups, and SESs. During the first phase in 2000 to 2004 (IPSR, 2001, 2005), the KDSS was an annual enumeration of all persons in every household in the field site communities. The primary objective of the KDSS was to monitor population changes in terms of demographic, social, economic, and health dimensions of the population within the study areas of 100 sampling units comprising 87 rural villages and 13 urban census blocks.

Two KDSS projects that provide longitudinal data for older people in terms of demographic, economic, cultural, and health dimensions are the "Health and Social Support for the Elderly in the KDSS" project and the "Population, Economic, Social, Cultural, and Long-term Care Surveillance for Thai Elderly People's Health Promotion" project. The former project was conducted with support from King's College London during 2006 to 2007. It aimed to study social support among older people whose children left home to work to get more useful information for determining policy implementation related to health promotion and prevention for older people. The latter project was conducted with support from the National Research University (NRU) in 2011. The NRU project in 2011 was conducted by following the same older people surveyed in the 2007 KDSS project. With different objectives, the NRU project was not specifically focused only on older people whose children left home to work. Its objectives were aimed to recommend policy implementation on the value, potential, and health promotion of older people, and to develop a useful database and necessary information for demographic surveillance among older people.

Based on the results of the previous study examining changes between two KDSS surveys in 2006 and 2007 (Ford, Punpuing, & Abas, 2016), it was recommended that the change model would produce better estimates by using a longer time period between the surveys. They found that it was difficult to find significant changes among variables measured in the 2006 KDSS and the 2007 KDSS. Therefore, this study was interested in examining changes over a longer period of time. This study used data from the 2007 and 2011 surveys to investigate changes in cognition among older people in the KDSS. In conclusion, the samples were only older Thais (i.e., age 60 years or above) who were interviewed in the 2007 project and were re-interviewed in the NRU project in 2011.

Study Samples

The inclusion criteria for this study specified older Thais who participated in both 2007 and 2011 KDSS. However, the important issue related to attrition and selection bias should be addressed. Therefore, both older people who dropped out in 2011 and cases with missing data for the variables of interest were excluded from the analysis of

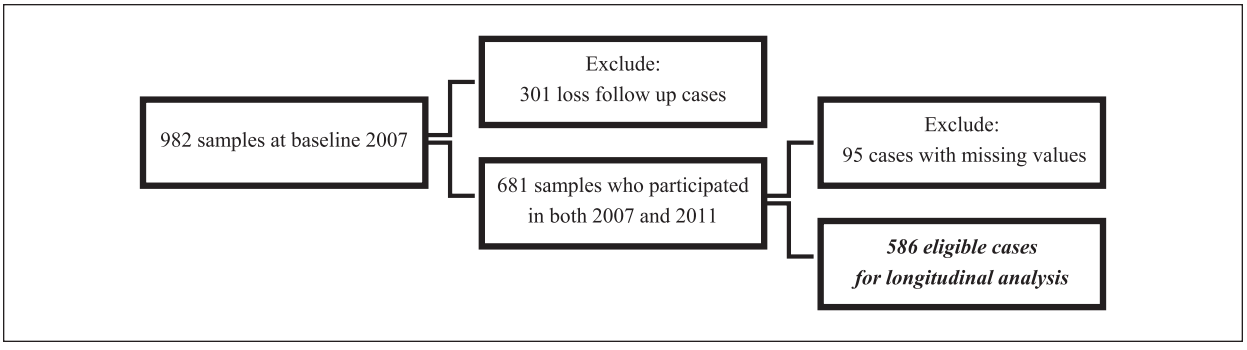

Figure 1. Flowchart of eligible cases for longitudinal analysis.

this study. In the 2007 KDSS, 982 older people were successfully interviewed. In the 2011 KDSS, 681 people were identified as having participated in both 2007 and 2011, accounting for 69% of the sample in 2007. Next, 95 older people had to be excluded from this analysis due to missing data for key variables. That left only 586 older people with complete data for both years, accounting for 60% of the total older people in 2007 (Figure 1).

Cognitive Impairment

According to the guidelines for dementia diagnosis, cognitive impairment needs to be present in at least two cognitive domains (McKhann et al., 2011). This study applied the category fluency task and the 10-word list delayed recall task to screen for cognitive impairment. The category fluency task is used for detecting the presence of dementia and is widely used both in research and in clinical settings (Cannings, Leach, Stuss, Ngo, & Black, 2004; Caramelli, Carthery-Goulart, Porto, Charchat-Fichman, & Nitrini, 2007). A subject is asked to name as many different animals as he or she can within 1 minute. The suggested cut-off score of 15 with a sensitivity of 88% and a specificity of 96% was reported to be applied for differentiating patients with Alzheimer's disease from non-Alzheimer's older persons (Cannings et al., 2004). Thus, scores below 15 indicated impaired cognition. The values were coded as 0 for non-impaired cognition and 1 for cognitive impairment.

The delayed recall task or the 10-word list delayed recall task asks the respondent to memorize 10 words (Rice, Hand, Letter, the Prime Minister, Ticket, Tree, Chair, Rock, Book, and Chopstick). Then, the respondent is asked to name all the words that he or she can remember. This diagnostic is recommended to help distinguish between persons with dementia and those with normal cognition (Fillenbaum et al., 2008). A cutoff of less than 5 words on the delayed recall task with a sensitivity of 94% and a specificity of 82% was recommended to detect dementia (Galvin, Roe, & Morris, 2007). The delayed recall test was also coded as 0 for normal (i.e., non-impaired) cognition and 1 for cognitive impairment. It is possible that both tasks were influenced by literacy of the respondents. Naming animals and recalling 10 words requires facility in use of language. It has been reported that, variation in literacy level may lead to misdiagnosis of dementia (Caramelli et al., 2007).

Each of cognitive tasks were classified into two values which are 0 (normal cognition) and 1 (cognitive impairment). However, this study measured cognition of older people by integrating both the category fluency task and the delayed recall task. Therefore, only older people who were coded as having cognitive impairment for both tasks were classified into the cognitively impaired group (which was coded as "1"). However, older people who met the non-impaired threshold for both tasks or at least one task were classified into the normal cognition group (which was coded as "0") (Table 1).

SDH

The conceptual framework of this study is based on the SDH concept which focuses on the impact of socioeconomic and environmental factors on health conditions. SDH can be defined as

> the conditions, in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems. (World Health Organization, n.d.)

The SDH concept covers various aspects of a person's health condition including individual, social, environmental, and policy contexts. Therefore, SDH can provide a more comprehensive picture about the health condition of older people. This study categorized SDH into social conditions, economic conditions, and living conditions (Table 2).

Living arrangement was grouped into four types: (a) a one-person household, (b) nuclear family, (c) extended family, and (d) other households. The questions related to *social relationship* were derived from three items asking older people to indicate how often they communicate with their children, relatives, and friends. Each

Table 1. Measurement of Cognitive Impairment.

	Category fluency task		Delayed recall task		
Patterns	Normal	Impaired	Normal	Impaired	Classifications
I	✓		✓		Normal cognition
II	✓			✓	Normal cognition
III		✓		✓	Normal cognition
IV		✓		✓	Cognitive impairment

Table 2. Operational Definitions of SDH.

SDH	Description	Values
Living arrangement	Family types	1 = One-person household 2 = Nuclear family 3 = Extended family 4 = Other households
Social relationship (children/relatives/friends)	Communication with children, relatives, and friends	0 = Not every day/no children, relatives, friends 1 = Everyday
Wealth index	An asset-based indicator including assets, infrastructure, and housing characteristics	1 to 5 (poorest to richest)
Household income	Average income per month per household	1 to 5 (poorest to richest)
Loans for living	Daily consumption, debts, medical care	0 = No (wealthy)/1 = Yes (poor)
Loans for investment	Business investment and vehicles	0 = No (poor)/1 = Yes (wealthy)
Working status	Current working status	0 = Not working/1 = Working

Note. SDH = social determinants of health.

social relationship component was classified as "no communication every day" or "having communication every day." This study applied principal component analysis (PCA) to develop *household wealth index* comprising 19 items of household assets, five items of facilities and infrastructures, and two items of housing characteristics. The wealth index was ranked into quintiles from the first (poorest) to the fifth (richest) quintiles. Older people who were in the poorest group were classified as staying in the household with the poorest economic status assessed by the wealth index.

Household monthly income referred to average income per household per month and was ranked into quintiles as well. *Household loans for living* referred to any loans that a household held for basic necessities. It was based on the concept that the household that held loans for daily living might experience some financial difficulties. It was calculated by summing the total amount of loans for consumption, paying debts, and spending for medical care. "*No loans for living*" denotes "wealthy" and "*have loans for living*" denotes "poor." "*Household loans for investment*" was another type of loan that a household might hold but was used for business investment and/or for purchasing vehicles. Any household that held loans for investment might not be poor but they might need money for starting their businesses. "*No loans for investment*" denotes "poor" and "*have loans for investment*" denotes "wealthy." "*Working status*" refers to current working state of the respondent which was coded as "not working" and "still working."

Age, gender, marital status, education level, and depression were considered as confounding variables (Table 3). *Gender* was coded as 0 for male and 1 for female. *Age* (defined as 60 years or older) was divided into five groups including 1 (age 60-64), 2 (age 65-69), 3 (age 70-74), 4 (age 75-79), and 5 (age 80 or above). The item about *marital status* from the KDSS was coded as 0 for not currently married and 1 for currently married. *Education* refers to the highest educational level attained. At that time, the Thai compulsory education system was primary grade 4, and response was divided into 0 (no schooling), 1 (less than or equal to primary grade 4), and 2 (more than primary grade 4). *Depression* was assessed by the EURO-D screening depression which consists of a checklist for 12 symptoms of depression. This study used a suggested cut-off point of 5/6 for major depressive episodes (Jirapramukpitak, Darawuttimaprakorn, Punpuing, & Abas, 2009). Scores of less than 6 were coded as 0 for normal, whereas scores of 6 or above were coded as 1 for depression.

Data Analysis

Stata/SE 12.0 (StataCorp, Texas, USA) was used for analysis. The generalized estimating equation (GEE) model was used to examine the impact of change in SDH on change in cognition. GEE was proposed as an

Table 3. Measurement of Confounding Variables.

Variables	Description	Values
Gender	Gender of the elderly	0 = Male/1 = Female
Age	Age group of the elderly	1 = 60-64 2 = 65-69 3 = 70-74 4 = 75-79 5 = 80 or older
Marital status	Current marital status	0 = Not married/1 = Married
Education	Highest educational level	0 = No formal schooling 1 = Less than or equal to primary grade 4 2 = More than primary grade 4
Depression	Depression assessed by the EURO-D	0 = Normal/1 = Depression

extension of generalized linear models for analyzing longitudinal data (Liang & Zeger, 1986). The GEE is a population average model that focuses primarily on the mean structure of the repeated measures and considers the within-subject covariance structure as a nuisance characteristics of the data. The analysis produces a predictive model by taking into account the possible correlation structure among the repeated measures of the outcome variable of a subject (Cui & Qian, 2007). For estimating the regression parameters, GEE requires the correct specification of the working correlation structure that represents the within-subject correlation between repeated measures of responses on outcome variables.

Three GEE models with the unstructured correlation structures were constructed in this study. The dependent variable was "cognitive impairment" derived from 2007 and 2011 for each participant. Predictor variables, including SDH and confounding variables, were also derived from longitudinal data from 2007 and 2011. All confounding variables (gender, age, marital status, education, depression, and year of KDSS) were controlled in every model. The first model contained the controlled variables and only social conditions of SDH. The second model contained all the controlled variables, social conditions of SDH, and economic conditions of SDH. The third model contained all of the variables of interest in this study.

Results

Demographic Characteristics

The descriptive analysis of demographic characteristics showed that the majority of older people in the KDSS at baseline 2007 were female, younger, and low educated (Table 4). Females outnumbered males among older people (58% and 42%, respectively). The majority of older people were still young: 33% for age 65 to 69% and 24% for age 60 to 64. Most had low education in general. Almost 70% had highest educational attainment of less than or equal to primary grade 4. Approximately 26% had no formal education.

Table 4. Characteristics of the Older Thais at Baseline 2007.

Characteristics at baseline 2007	*N*	%
Total	586	100.0
Gender		
Male	249	42.5
Female	337	57.5
Age group		
60-64	141	24.1
65-69	195	33.3
70-74	114	19.5
75-79	103	17.6
≥ 80	33	5.6
Marital status		
Not currently married	244	41.6
Currently married	342	58.4
Education		
No schooling	151	25.8
≤ primary grade 4	395	67.4
> primary grade 4	40	6.8

Longitudinal Effects on Cognition

Table 5 presents the results of the GEE models for the effect of SDH characteristics and all confounding variables on cognition of 586 older Thais in the KDSS in 2007 and 2011. The first GEE model included only social conditions of SDH (living arrangement and social relationship with children, relatives, and friends) and controlled for time and confounding variables. There were no significant relationships between all social conditions of SDH and cognition of older Thais. In addition, there was no significant relationship between year of KDSS and cognition. The first model implies that only living arrangement and social relationship with children, relatives, and friends could not predict change in cognition of older Thais in the KDSS when controlling for gender, age, marital status, education, and depression. However, only two confounding variables (age and education) were found to be statistically significant in the first model. Older people in the oldest age group (80 years or older) were 3.2 times

more likely to have cognitive impairment than older people in the youngest group (60-64 years old). Also, older people aged 70 to 74 and aged 75 to 79 were 1.9 times and 2.9 times, respectively, more likely to have cognitive impairment compared with the youngest group. For education, older people who had higher than primary grade 4 education were 64.3% less likely to have cognitive impairment compared with older people who had no education.

The second GEE model shows that, after adding economic conditions of SDH (wealth index, household monthly income, loans for living, and loans for investment) into the model, only wealth index remained significantly related to cognition. Older people living in households with the rich and the richest wealth index quintiles were 47.1% and 42.6%, respectively, less likely to have cognitive impairment than older people living alone. The second model also indicates that economic conditions helped reduce the impact of age on cognitive impairment. The odds ratios declined after adding economic conditions into the first model. Older people in the oldest age group were 3.1 times more likely to have cognitive impairment than older people in the youngest group. Also, older people aged 70 to 74 and aged 75 to 79 were 1.8 times and 2.8 times, respectively, more likely to have cognitive impairment compared with the youngest group.

The third GEE model includes all SDH characteristics by adding living conditions of SDH (working status) and controlling for time and confounding variables. Only the wealth index, working status, and age were found to be significantly related to cognition of older people. By contrast, the odds ratio for the association between education and year of KDSS and cognition became slightly attenuated and insignificant in the third model. Regarding SDH characteristics, only wealth index and working status were found to be significant predictors of cognitive impairment. The second and the third models reveal that older people living in a household with the rich and the richest wealth index quintiles were approximately 42.6% to 49.2% less likely to have cognitive impairment than older people who lived in a household with the poorest wealth index quintile. After adding working status into the model, the odds ratios of wealth index in the third model decreased slightly compared with the second model. Nevertheless, the results were still at the same level. Although statistically insignificant relationships were found among older people who lived in a household with a poor or the moderate wealth index quintiles, the odds ratios tended to decrease by the higher levels of the wealth index. These findings show that the richer the wealth index, the less likely to become cognitively impaired. In terms of working status, the results indicate that older people who were identified as working people were 35% less likely to have cognitive impairment than older people who were identified as non-working. In addition, working status helped reduce the impact of age on cognitive impairment. As presented in the second and third models, the odd ratios of age group in the third model declined after adding working status into the second model. This implies that working status can help reduce risk of cognitive impairment.

For all controlled variables (including confounding variables), only age was found to be strongly related to cognition of older people in all models. Although statistically insignificant relationships were found among older people in some age groups (age 65-69 and age 70-74), the odds ratios were found to be more likely to increase as age of older people increased. However, gender, marital status, and depression were found to be not associated with cognitive impairment. For education, only the first and second models show statistical significance among the higher educated people. The results show that older people with higher education than primary grade 4 were less likely to have cognitive impairment than older people with no education. However, after including all SDH characteristics into the model, a significant relationship between education and cognition was not found as was the case in the third model. This indicates that SDH characteristics had greater impact on cognition than education.

In conclusion, the GEE model revealed that three variables had a significant effect on cognition of older people: wealth index, working status, and age of the elderly. Older people living in a household in the richer wealth index quintile and working were less likely to have cognitive impairment than those living in a household in the poorest wealth index quintile and not working. Also, people at the more advanced ages were more likely to have cognitive impairment than those in the youngest age group. More importantly, wealth index and working status could help reduce the risk of cognitive impairment among older people.

Discussion

The longitudinal analysis confirmed that advanced age was still the greatest risk factor for cognitive impairment. With regard to the effects of SDH over time, there was a significant influence of only the wealth index and working status on cognition. The results show that the people who lived in a wealthy household (assessed in terms of wealth index) were less likely to have cognitive impairment than people who lived in the poorest households. This finding is consistent with other studies that found an association between wealth index and cognitive ability (Cadar et al., 2018; Cagney & Lauderdale, 2002). Also, "wealthier" in the wealth index measure referred to having more assets, having better infrastructure, and having a better housing environment. Therefore, a higher score for the wealth index would enable older people to have more opportunities and a better environment for reducing risk of cognitive impairment. For example, this advantage helps older people obtain better access to and affordability of health care. The use of the wealth index as an indicator of SES should be done with caution. As shown from previous studies, variation in the components used

Table 5. Odds Ratios for the GEE Models of the Effect of SDH on Cognition.

	Model 1		Model 2		Model 3	
Predictors	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Living arrangement (Ref: One person household)						
Nuclear family	1.14	[0.68, 1.92]	1.29	[0.75, 2.22]	1.26	[0.72, 2.18]
Extended family	1.19	[0.72, 1.97]	1.44	[0.84, 2.49]	1.37	[0.79, 2.37]
Others	1.38	[0.66, 1.96]	1.42	[0.78, 2.58]	1.31	[0.72, 2.39]
Social relationship with children (Ref: Not every day)						
Every day	1.03	[0.74, 1.46]	1.09	[0.77, 1.54]	1.07	[0.76, 1.52]
Social relationship with relatives (Ref: Not every day)						
Every day	0.85	[0.61, 1.18]	0.83	[0.60, 1.16]	0.83	[0.59, 1.15]
Social relationship with friends (Ref: Not every day)						
Every day	0.83	[0.63, 1.09]	0.82	[0.62, 1.07]	0.83	[0.63, 1.10]
Wealth index (Ref: Poorest)						
Poor			0.93	[0.61, 1.43]	0.93	[0.61, 1.43]
Moderate			0.80	[0.50, 1.28]	0.79	[0.49, 1.26]
Rich			0.53*	[0.32, 0.88]	0.51**	[0.31, 0.85]
Richest			0.57*	[0.33, 1.00]	0.54*	[0.31, 0.94]
Household monthly income (Ref: Poorest)						
Poor			0.83	[0.55, 1.25]	0.84	[0.56, 1.26]
Moderate			1.00	[0.64, 1.57]	1.00	[0.63, 1.56]
Rich			1.08	[0.69, 1.69]	1.07	[0.68, 1.68]
Richest			1.08	[0.64, 1.83]	1.10	[0.65, 1.88
Loans for living (Ref: No loans/Wealthy)						
Have loans/Poor			0.95	[0.64, 1.40]	0.94	[0.64, 1.39]
Loans for investment (Ref: No loans/Poor)						
Have loans/Wealthy			1.01	[0.75, 1.36]	1.06	[0.79, 1.43]
Working status (Ref: Not working)						
Working					0.65**	[0.47, 0.89]
Constant	0.31**		0.33**		0.46	
Wald Chi^2	74.89		82.71		88.56	
Number of observations	1,172		1,172		1,172	
Number of respondents	586		586		586	

Note. Model 1 contained all controlled variables and only social conditions of SDH. Model 2 contained all controlled variables, social and economic conditions of SDH. Model 3 contained all controlled variables, social, economic, and living conditions of SDH. CI = confidence interval; SDH = social determinants of health.
*$p < .05$. **$p < .01$.

for constructing the wealth index might influence the results (Cagney & Lauderdale, 2002; Campos-Vazquez, Medina-Cortina, & Velez-Grajales, 2018). This study also supported the contention that wealth had a stronger association with cognitive function than income. There was no significant effect of household monthly income, loans for living expenses, and loans for investment on cognition. A possible explanation was that income-based indicators were found to be less reliable due to the relatively high non-response rate and under or over reporting of income items (Córdova, 2009).

Working status could help reduce risk for cognitive impairment over time. This finding is consistent with previous studies that found that encouraging older people to work after retirement prevents dementia (Dufouil et al., 2014; Grotz et al., 2015). The beneficial effect of certain types of physical activity on cognitive ability has been reported (Ahlskog, Geda, Graff-Radford, & Petersen, 2011). In the context of older people in the KDSS, this study did not take physical activity into consideration. However, it can probably be assumed that physical activity is related to the main occupation, for example, skilled agricultural, forestry, and fishery work, all of which would require physical exertion in daily life. Therefore, it could be concluded that continuing to work would be protective of cognitive decline in those persons. In addition, working after retirement is another way to earn supplemental income, and that would help them to maintain their economic status. In conclusion, the results strongly support the contention that being employed after retirement will promote a healthier later life (Haseen, Adhikari, & Soonthorndhada, 2010; Shim & Kang, 2017).

No social conditions had a longitudinal influence on cognition. It is possible that using only a quantitative measure of social conditions (e.g., frequency of communication with others) might not be an effective indicator for assessing cognitive ability over time. A qualitative measure of social conditions such as participation in social activities, social networking, and positive or negative social relationships might be more accurate.

Although, there was no significant association between living arrangement and cognition in this analysis, older people in co-resident living arrangements tended to have more cognitive impairment than those living alone. Within the Thai context, adult children were expected to dote on their parents and, thus, that may reduce independent functional ability of older people. In other words, it is possible that older people living alone might have more opportunity to enhance their cognitive ability than those living with younger relatives. Nevertheless, this study did not find any significant relationship between social conditions and cognition over time. These findings might reflect that the social conditions in 2007 and 2011 were mostly stable across social indicators. The low percentage of change might not be strong enough to impact cognition over time.

This study had some limitations. First, it is important to note that attrition bias and missing data are common problems for longitudinal studies. Although this study applied the complete-case analysis approach to manage these biases, interpretation of the findings needs to be done with caution. Second, population change is a dynamic system that needs to be updated along with the social and environmental context. The observations from past experience might not be able to reflect current cognitive conditions. Third, the samples for this study are limited to only the study areas of the KDSS. Thus, the results are not necessarily applicable to the total population of Thailand. Fourth, this study only focused on the effects of SDH on cognition over time. Other variables possibly influencing cognition include area of residence, lifestyle behavior, physical activity, health problems, income per capita, social activities, and quality of social relationships. Future studies need to consider these variables.

Conclusion

The empirical results suggested that being in a richer household (i.e., asset-based wealth index) and working after retirement were significant protective factors for cognitive impairment over time. The government and private sector should pay more attention to these issues in order to prevent/delay cognitive impairment. For example, there should be sustainable economic support from the government or the private sector for every household in the community. There should be programs to improve the quality of the assets, facilities, infrastructure, and housing in order that more older people end up in the wealthier households in terms of asset-based wealth status. In addition, promotion of rewarding employment among older people is urgently needed in its own right. The government and the private sector should provide older people with more opportunities to be employed after retirement or after reaching age 60. There should be campaigns to encourage older people to work in fulfilling occupations and participate in community activities in order to use their cognitive and physical abilities in their everyday lives. Also, there should be more research on this same topic but in other areas of Thailand or in similar countries. Future research should pay more attention to older people living in distinctly different areas so that the data may expose other patterns of change in cognition.

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