Original Article

Comparison of Prevalence and Risk Factors Associated with Cognitive Impairment between Rural and Urban Elderly in Thailand

Sariyamon Tiraphat PhD[1], Wichai Aekplakorn MD, PhD[2]

[1] ASEAN Institute for Health Development, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom, Thailand
[2] Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Ratchathewi, Bangkok, Thailand

Objective: To examine the prevalence and risk factors of cognitive impairment in Thai older population living in urban and rural across the country.

Materials and Methods: The present study used data from the fourth Thai National Health Examination Survey [NHES IV]. The study population was 6,633 Thai elderly aged 60 years and older living in urban and rural area. Chi-square and multiple logistic regression analysis were applied to investigate prevalence and predictors of being cognitive impairment among the elderly.

Results: Prevalence of cognitive impairment among older Thai was 10.2%, with 11.7% and 8.7% in rural and urban, respectively. Significant predictors of the impairment among Thai elderly in both rural and urban included living region, gender, age, education, and active leisure. In addition, perceived poor health status was a significant predictor of the impairment in urban elderly, whereas poor economic condition was a significant predictor of the impairment in rural elderly.

Conclusion: The present study has confirmed that education and active leisure are protective factors against cognitive impairment among Thai elderly. However, poor economic condition and perceived poor health status are the risk factors associated with cognitive decline in rural and urban elderly, respectively.

Keywords: Cognitive impairment, Urban, Rural, Thai elderly

Thailand is concerned about aging population. The country established the National Elderly Council to address issues impacting the elderly in 1982[1]. According to the International Health Policy Program [IHPP], Thailand, life expectancy for Thai male and female have been increasing from 55.9 and 62.0 in 1964 to 71.3 to 78.2 in 2004. Although life expectancy is increasing, health problems from illness and disability are not decreasing[2]. Chronic diseases are the leading causes of disability in Thailand[3]. Among the diseases, neuropsychiatric disorders are the top leading causes of disability-adjusted life years [DALYs] loss with the highest disease burden as dementia[4]. Dementia is a group of cognitive impairment associated with memory loss causing dependency and poor quality of life among the elderly. The stages of dementia vary from mild to severe cognitive impairment. With mild cognitive impairment, people are still be able to do their daily activities with little changes in cognitive functions, while people with severe impairment are unable to conduct their everyday activities resulting in living dependently[5,6]. With worldwide concern about dementia, researches focusing on cognitive impairment that try to delay the onset of dementia have been widely studied[7]. In Thailand, a few studies[8-10] related to cognitive impairment were conducted but the study sample were small and from hospital-based data. To prevent or delay cognitive impairment among Thai elderly, research to understand risk factors associated with cognitive impairment of the elderly that represents the whole country is needed. With the disparity in people's lifestyles and characteristics between rural and urban areas, it is challenging to examine the prevalence and risk factors associated with the cognitive impairment by urban and rural contexts. Understanding factors associated with cognitive impairment among the elderly in urban and rural parts can give proper interventions to delay the progression of severe dementia effectively. Therefore, the present study will examine prevalence and risk

Correspondence to:

Tiraphat S. ASEAN Institute for Health Development, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand.
Phone: +66-2-4419040-3, **Fax**: +66-2-4419044
Email: sariyamon.tir@mahidol.ac.th

factors of cognitive impairment among Thai older population using the cognitive measures of the national representative samples of the elders in urban and rural area.

Materials and Methods
Study population
The present study used data from the Fourth Thai National Health Examination Survey [NHES IV][11], conducted between 2008 and 2009, which was a four-stage stratified sampling from provinces, districts, villages, and to the individuals. The study population was 6,633 Thai elderly aged 60 years and older, living in urban and rural area. Urbanization was classified from electoral units that were categorized as "urban" and "rural" areas of residence. Sample size took account of 3,366 elderly in urban and 3,297 elderly in rural. The study was approved by the Ethical Review Committee on Human Right Related to Research involving Human Subjects, Faculty of Medicine, Ramathibodi Hospital, Mahidol University (No. MURA2013/323).

Variables
Dependent variable: The dependent variable was the status of cognitive impairment. In addition to performing interview and conducting physical exam, the NHES IV team conducted cognitive impairment screening test for older persons aged 60 years and older. The NHES used the standard screening instrument for detection of cognitive impairments called the Mini-Mental State Examination [MMSE] Thai version 2002, obtained from the Institute of Geriatric Medicine, Department of Medical Services; Ministry of Public Health, Thailand. The MMSE is an effective screening tool for cognitive impairment with older community dwelling, hospitalized and institutionalized adults taking only 5 to 10 minutes to perform. This instrument evaluates the individual's cognition covering the brain functions of orientation, registration, attention and calculation, recall, language, and ability to follow simple commands. From this instrument, the participants were asked to complete 11 questions including orientation for time, orientation for place, registration, attention/calculation, recall, naming, repetition, verbal command, written command, writing, and visuoconstructional skill. The final score ranged from 0 to 30. Full score and cut-off point for cognitive impairment was based on education level. The cut-off point was 17 or less from full score of 30 for elderly with elementary school, and cut-off point of 22 or less

from full score of 30 for elderly with higher elementary education. The participants who got the score below cut-off point indicated cognitive impairment. After getting cut-off point, the status of cognitive impairment was categorized as yes or no.

Independent variables: Twelve predictors were included to analyze in the present study. Socioeconomic status included age level (60 to 69 years old, 70 to 79 years old, and 80 years and higher), educational level (categorized as graduated below fourth grade or above), economic status (respondents were asked whether they had enough money to afford, categorized as yes/no), marital status (categorized as married and isolate/divorce/separate/widow), and living arrangement (categorized as living alone and living with others). Health factors included having diabetes (categorized as yes/no), high blood pressure disease (categorized as yes/no). Perceived health status was categorized as poor/fair or good/very good. Active leisure was evaluated from the questionnaire where the respondents were asked "How often do you participate in leisure-time physical activity that lasts at least 10 minutes and causes breathlessness and sweating?". From the answer, participants who participated in leisure activity at least two times per week were classified as active, and all others were classified as sedentary. For smoking, the participants was asked "Do you currently smoke cigarette?" and classified as yes or no. For region variable, four regions of the country including North, South, Northeast, and Central were taken to study.

Statistical analysis
Descriptive analysis as characteristics of adults in Thailand population 60 years and older classified by urban/rural was analyzed. Then, the prevalence of cognitive impairment by urban and rural were assessed using chi-square. Finally, multiple logistic regression analysis was applied to investigate predictors and odds ratio of being cognitive impairment among the elderly in urban and rural. The analysis was conducted separately by urban and rural. The level of significance for all analyses was set at p-value of less than 0.05. All statistical analyses were conducted using IBM SPSS 18.

Results
The characteristics of population
The characteristics of population by urban/rural are presented in Table 1. Elderly evenly lived in four regions of the country, at approximately 25% of the

Table 1. Characteristics of adults in Thailand population 60 years and older (n = 6,633) classified by living area

	Total, n (%)	Rural, n (%)	Urban, n (%)
Overall sample	6,633 (100)	3,297 (49.7)	3,336 (50.3)
Region			
North	1,635 (24.6)	792 (24.0)	843 (25.3)
Central	1,732 (26.1)	860 (26.1)	872 (26.1)
Northeast	1,652 (24.9)	832 (25.2)	820 (24.6)
South	1,614 (24.3)	813 (24.7)	801 (24.0)
Gender			
Male	3,521 (53.1)	1,769 (53.7)	1,752 (52.5)
Female	3,112 (46.9)	1,528 (46.3)	1,584 (47.5)
Age level (year)			
60 to 69	3,813 (57.5)	1,857 (56.3)	1,956 (58.6)
70 to 79	2,248 (33.9)	1,146 (34.8)	1,102 (33.0)
80 and higher	572 (8.6)	294 (8.9)	278 (8.3)
Has enough money to afford			
No	3,587 (54.1)	1,870 (56.7)	1,717 (51.5)
Yes	3,046 (45.9)	1,427 (43.3)	1,619 (48.5)
Marital status			
Married	4,325 (65.2)	2,206 (66.9)	2,119 (63.5)
Isolate/divorce/separate	2,308 (34.8)	1,091 (33.1)	1,217 (36.5)
Educational level			
Below fourth grade	729 (11.0)	401 (12.2)	328 (9.8)
Fourth grade and higher	5,904 (89.0)	2,896 (87.8)	3,008 (90.2)
Living arrangement			
Live alone	500 (7.5)	228 (6.9)	272 (8.2)
Live with other	6,133 (92.5)	3,069 (93.1)	3,064 (91.8)
Diabetes			
Yes	1,071 (16.1)	445 (13.5)	626 (18.8)
No	5,562 (83.9)	2,852 (86.5)	2,710 (81.2)
High blood pressure			
Yes	3,276 (49.4)	1,503 (45.6)	1,773 (53.1)
No	3,357 (50.6)	1,794 (54.4)	1,563 (46.9)
Perceived health status			
Poor/fair	3,911 (59.0)	2,019 (61.2)	1,892 (56.7)
Good/very good	2,722 (41.0)	1,278 (38.8)	1,444 (43.3)
Active leisure			
No	5,227 (78.8)	2,743 (83.2)	2,484 (74.5)
Yes	1,406 (21.2)	554 (16.8)	852 (25.5)
Current regular smoker			
No	5,505 (83.0)	2,609 (79.1)	2,896 (86.8)
Yes	1,128 (17.0)	688 (20.9)	440 (13.2)

population per region. Overall, there were slightly more male elderly than the female. Most of the respondents were in 60 to 69 years of age, more than half of them did not have enough money. Most of them were married, more than 80% of them graduated fourth grade and higher, and lived with others. Most of them did not have diabetes but almost half of them had high blood pressure. More than half of the respondents perceived their health as poor/fair. The 20.9% of elderly in rural currently smoked while only 13.2% of those in urban did. Most respondents did not have active leisure.

Table 2 indicates that total prevalence of cognitive impairment for all populations. It was 10.2% with the prevalence of Thai elderly with cognitive impairment in urban and rural at 8.7% and 11.7%, respectively. The results of chi-square analysis showed that factors associated with the prevalence of impairment in both urban and rural were living region with highest prevalence in the South. Gender with higher prevalence was in female. Aging with the highest impairment

Table 2. Prevalence of elderly living in urban and rural area in Thailand who are cognitive impairment, by socio-demographic and health factors

	Study areas, No. of case/total (%)		
	Total	Rural	Urban
Cognitive impairment			
Yes	675/6,633 (10.2)	385/3,297 (11.7)	290/3,336 (8.7)
Region[a,b]			
North	140/1,635 (8.6)	88/792 (11.1)	52/843 (6.2)
Central	142/1,732 (8.2)	76/860 (8.8)	66/872 (7.6)
Northeast	140/1,652 (8.5)	80/832 (9.6)	60/820 (7.3)
South	253/1,614 (15.7)	141/813 (17.3)	111/801 (13.9)
Gender[a,b]			
Male	297/3,521 (8.4)	177/1,769 (10.0)	120/1,752 (6.8)
Female	378/3,112 (12.1)	208/1,528 (13.6)	170/1,584 (10.7)
Age level (year)[a,b]			
60 to 69	227/3,813 (6.0)	139/1,857 (7.5)	88/1,956 (4.5)
70 to 79	294/2,248 (13.1)	171/1,146 (14.9)	123/1,102 (11.2)
80 and higher	154/572 (26.9)	75/294 (25.5)	79/278 (28.4)
Has enough money to afford			
No	397/3,587 (11.1)	236/1,870 (12.6)	161/1,717 (9.4)
Yes	278/3,046 (9.1)	149/1,427 (10.4)	129/1,619 (8.0)
Marital status[a,b]			
Married	370/4,325 (8.6)	229/2,206 (10.4)	141/2,119 (6.7)
Isolate/divorce/separate	305/2,308 (13.2)	156/1,091 (14.3)	149/1,217 (12.2)
Educational level[a,b]			
Below fourth grade	196/729 (26.9)	123/401 (30.7)	73/328 (22.3)
Fourth grade and higher	479/5,904 (8.1)	262/2,896 (9.0)	217/3,008 (7.2)
Living arrangement[b]			
Live alone	57/500 (11.4)	24/228 (10.5)	33/272 (12.1)
Live with other	618/6,133 (10.1)	361/3,069 (11.8)	257/3,064 (8.4)
Diabetes			
Yes	99/1,071 (9.2)	51/445 (11.5)	48/626 (7.7)
No	576/5,562 (10.4)	334/2,852 (11.7)	242/2,710 (8.9)
High blood pressure			
Yes	358/3,276 (10.9)	188/1,503 (12.5)	170/1,773 (9.6)
No	317/3,357 (9.4)	197/1,794 (11.0)	120/1,563 (7.7)
Perceived health status[b]			
Poor/fair	438/3,911 (11.2)	243/2,019 (12.0)	195/1,892 (10.3)
Good/very good	237/2,722 (8.7)	142/1,278 (11.1)	95/1,444 (6.6)
Active leisure[a,b]			
No	595/5,227 (11.4)	346/2,743 (12.6)	249/2,484 (10.0)
Yes	80/1,406 (5.7)	39/554 (7.0)	41/852 (4.8)
Current regular smoker			
No	569/5,505 (10.3)	316/2,609 (12.1)	253/2,896 (8.7)
Yes	106/1,128 (9.4)	69/688 (10.0)	37/440 (8.4)

[a] Significant factors were associated with being cognitive impairment among rural population (*p*<0.05) by Chi-square
[b] Significant factors were associated with being cognitive impairment among urban population (*p*<0.05) by Chi-square

was in late old age. Marital status by the higher prevalence was in isolated group. Education with the higher prevalence was in the elderly with below fourth grade. Finally, active leisure with lower activity related with higher cognitive impairment. However, living arrangement and perceived health status were found to be associated with the occurrences of cognitive impairment among urban population, but not the rural. The results showed that, in urban area, the elderly living alone were more likely to develop cognitive impairment more than those living with others, and the elderly perceiving good health status were more likely to develop cognitive impairment lower than those perceiving poor health.

After adjusting for other variables, significant predictors of cognitive impairment among Thai elderly in both rural and urban area were living region, gender, age, education, and active leisure. Namely, the elderly in the Southern region, female, late old age, lower education, and lower active leisure were more likely to develop cognitive impairment than their counterparts. However, the other significant predictor of cognitive impairment in urban elderly but not in the rural was perceived health factor. The other significant predictor of cognitive impairment in rural elderly but not in the urban was economic factor. Elderly in urban who perceived their poor health were more likely to develop cognitive impairment 1.32 times comparing to those defined themselves as healthy. Elderly in rural area who did not have enough money were more likely to develop cognitive impairment 1.26 times comparing to those with enough money.

Discussion

Prevalence of cognitive impairment among older Thai was 10.2%, with 11.7% in the rural and 8.7% in the urban. The results indicated that the prevalence of cognitive impairment in both urban and rural were more common in the elderly living in the South, female, advanced age, being isolation/divorce/separation/widow, with lower education, and having a lower active leisure. In addition, in urban area, the prevalence of cognitive impairment was more common in the elderly living alone and perceiving poor health status. After adjusting for other variables using multiple logistic regression, similar significant predictors of cognitive impairment among Thai elderly in both urban and rural included living region, gender, age, education, and active leisure. Different significant predictors were perceived poor health as a significant predictor of cognitive impairment in urban elderly but not in

Table 3. Multiple logistic regression analyses of the relationship between participant's cognitive impairment and multivariate factors in urban and rural areas

Variables	Rural OR* (95% CI)	Urban OR* (95% CI)
Region[a/b]		
North	0.96 (0.74 to 1.24)	0.73 (0.49 to 1.08)
South	2.09 (1.66 to 2.63)	1.93 (1.37 to 2.71)
Northeast	1.10 (0.85 to 1.43)	1.09 (0.74 to 1.59)
Central (reference)	1	1
Gender[a/b]		
Female	1.33 (1.10 to 1.62)	1.46 (1.08 to 1.96)
Male (reference)	1	1
Age level (year)[a/b]		
80 and higher	4.77 (3.73 to 6.11)	6.82 (4.74 to 9.83)
70 to 79 years	2.06 (1.70 to 2.49)	2.31 (1.72 to 3.10)
60 to 69 years (reference)	1	1
Educational level[a/b]		
Below Fourth grade	3.27 (2.68 to 4.00)	2.83 (2.06 to 3.89)
Fourth grade and above (reference)	1	1
Has enough money to afford[a]		
No	1.27 (1.07 to 1.51)	1.23 (0.95 to 1.61)
Yes (reference)	1	1
Marital status		
Isolate/divorce/separate	1.11 (0.92 to 1.35)	1.17 (0.86 to 1.57)
Married (reference)	1	1
Living arrangement		
Live alone	0.96 (0.69 to 1.32)	1.29 (0.83 to 1.99)
Live with other (reference)	1	1
Diabetes		
Yes	1.04 (0.82 to 1.32)	0.95 (0.68 to 1.35)
No (reference)	1	1
High blood pressure		
Yes	1.02 (0.85 to 1.21)	1.11 (0.85 to 1.45)
No(reference)	1	1
Perceived health status[b]		
Poor/fair	1.09 (0.92 to 1.31)	1.32 (1.01 to 1.74)
Good/very good (reference)	1	1
Active leisure[a/b]		
No	1.75 (1.36 to 2.25)	1.69 (1.18 to 2.42)
Yes (reference)	1	1
Current regular smoker		
Yes	1.05 (0.82 to 1.34)	0.95 (0.63 to 1.42)
No (reference)	1	1

* Odds ratio obtained from multiple logistic regression adjusting for all variables presented in this table

[a] Significant risk factors were associated with the odds of being cognitive impairment among rural population (*p*<0.05) by multiple logistic regression

[b] Significant risk factors were associated with the odds of being cognitive impairment among urban population (*p*<0.05) by multiple logistic regression

the rural, and economic condition as a significant predictor of cognitive impairment in rural elderly but not in the urban.

The present study indicated that Southern part of Thailand has the highest prevalence of elderly having cognitive impairment. Therefore, examining mechanism underlying the disparity in cognitive

impairment by region is interesting for a future research. In term of gender, the results indicated that Thai women have a higher risk of cognitive impairment as compared to Thai men. The result was consistent with research from China[12], but different from research from USA[13]. As expected, aging condition was the major predictor of cognitive impairment among Thai elderly in both rural and urban. Previous research explained that brain transformation as an aging process is the main factor causing the impaired recall in elderly[14]. The present study also supported that higher education was a protective factor to delay the onset of cognitive impairment. Researchers documented that intellectual activities associated with education such as reading and writing can promote cognitive networks functionally and efficiently lead to delay the onset of clinical dementia in old age[15]. The results of the present study also supported that physical activity was associated with delay of mind cognitive decline in Thai elderly. Several mechanisms may underlie the potentially protective effects of physical activity on cognitive function. There was evidence indicating that aerobic exercise can increases size of hippocampus, which shrink in late adulthood leading to impaired memory[16]. Previous research from China also agreed that non-aerobic exercise like Taiichi could contribute a significant change to brain volume and improve cognition in randomized trials of non-demented elderly[17]. In addition to enhanced brain function, physical activity also protects against the development of neurodegenerative diseases[18].

In term of urban area, the prevalence of cognitive impairment was more common in the elderly living alone and perceiving poor health status. After adjusting for other variables, perceived poor health was the only significant predictor of cognitive impairment among urban elderly. In case of living arrangement associated with cognitive impairment among the urban elderly, social capital, the mechanisms whereby residents relate to and interact with each others to solve problems for the common good, may improve the relationship between living alone and cognitive impairment development. It was evident that most social capital in Thailand, such as social trust, social interaction, and social support deriving from family and community, and they are more common in rural area comparing with urban part[19]. A national cohort research in Thailand addressed that living in urban with low social trust and social support was significantly associated with poor physical and psychological health among the urban residence[19]. Another cohort study[20] in the

United States indicated strong correlation between high emotional support and better cognitive function among 1,189 US older adults. The researchers described that greater emotional support can lessen depression but strengthen self-efficacy beliefs that positively influence ability of cognitive aging. Therefore, it is reasonable for this current study to consider that living in urban communities with low social capital, such as low social trust, interaction, and support associated with negatively psychological health eventually resulting in rapid impairment of cognitive condition, in particular, the urban elderly living alone who are less likely to have social interaction and support. Consequently, the positive role of the social environment in protecting against cognitive declines among urban adults living alone is an important issue to be considered. Aspect of perceived health status associated with cognitive impairment among urban elderly, those living in urban area may be more conscious of their health, then they may be more likely to report poorer overall health[21]. Previous literature indicated the association of poorer self-ratings of health with higher risk of disease and mortality[22]. Therefore, it is important to follow the elderly who rated themselves as poor health condition. With this indication, health promotion associated with cognitive prevention will be needed, in particular, the elders who perceived poor health.

In rural area, economic condition was the significant predictor of having cognitive impairment among the elderly. Previous researches indicated that economic stress was a potential factor associated with poor health for poor people[23,24]. The research in Thailand[25] also revealed that changing from a kin-based to a cash-based economic system caused poor rural elders not getting enough quality of care. In addition, poor rural children need to leave their parents behind for job hunting elsewhere. Therefore, poverty comes to play a major role for designating quality of life associated with quality of care and caregiving the rural elders received. With this circumstance, improving economic condition among poor rural elders may be an effective intervention to promote healthy living associated with cognitive impairment among this sub group.

The findings from the present study indicated that cognitive ability among the elderly was significantly associated with both physical and social activities. Therefore, further research is recommended to combine three non-pharmacological intervention to strengthen the elderly's cognition. The first intervention for the older persons to fortify their

cognitive ability is doing physical activity, such as do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week. The second intervention is performing intellectual activities, such as frequent engagement in hobbies, including reading, puzzles, and games, for at least six hours per week. The third activity is socialization by engaging in social participation with family, friends, and communities regularly.

There are some limitations to the present study. First, the nature of cross-sectional design cannot confirm the causal relationships between cognitive impairment and the predictors. Second, MMSE as the screening test for cognitive impairment is affected by sociodemographic factors such as age, education, and socioeconomic background. Consequently, it may misclassify the MMSE's scores in some degree. However, the present study has its strength as a national representative study providing information for further monitoring the situation of cognitive impairment that is the critical concern facing the older population.

Conclusion

The prevalence of being cognitive impairment was higher in rural area. However, in urban, higher prevalence of cognitive impairment was found in the elderly living alone and perceived poor health status compared to those living with others and perceiving good health. The same protective factors of cognitive impairment among Thai elderly in both urban and rural included education, and active leisure. However, different risk factors of having cognitive impairment among urban and rural elderly were perceived poor health for urban elderly, and poor economic condition for rural elderly. To prevent cognitive impairment among Thai older population, recommendations of effective policies include 1) encouraging educational activities and active leisure towards the elderly, 2) promoting social capital, such as promoting social trust, social networking, and social support in aging communities especially in urban areas, 3) promoting health promotion and disease prevention especially in the elderly who have poor health, and 4) improving economic condition associated with quality of life specifically for poor rural elderly.

What is already known on this topic?

Dementia is a group of cognitive impairment associated with memory loss causing dependency and poor quality of life among the elderly. Cognitive impairment ranges from mild to severe. Increasing of aging population will result in substantially increased numbers of individuals with cognitive impairment.

What this study adds?

The prevalence of cognitive impairment among Thai elderly was higher in rural area, and Southern region of the country. In addition, higher prevalence cognitive impairment was in female elderly, poor elderly, isolated elderly, lower educated elderly, and elderly with lower active leisure. High-risk group of having cognitive impairment classified by area are elderly in urban area in perceived poor health, and elderly in rural area with poor economic condition. The present study gives strong evidence to support that education and leisure activity are protective factors of becoming cognitively impaired among Thai elderly in both rural and urban areas.

Acknowledgement

Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Jitapunkul S, Wivatvanit S. National policies and programs for the aging population in Thailand. Ageing Int 2008;33:62-74.
2. World Health Organization. Disability and health [Internet]. 2016 [cited 2016 Jan 24]. Available from: http://www.who.int/mediacentre/factsheets/fs352/en/.
3. Bundhamcharoen K, Odton P, Phulkerd S, Tangcharoensathien V. Burden of disease in Thailand: changes in health gap between 1999 and 2004. BMC Public Health 2011;11:53.
4. Muangpaisan W, Assantachai P. Health and ill health in the older population. Siriraj Med J 2009; 61:230-2.
5. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Tangalos EG, Kokmen E. Mild cognitive impairment: clinical characterization and outcome. Arch Neurol 1999;56:303-8.
6. Petersen RC. Mild cognitive impairment. Continuum: Lifelong Learning in Neurology 2004;10: 9-28.
7. Daviglus ML, Bell CC, Berrettini W, Bowen PE, Connolly ES Jr, Cox NJ, et al. NIH state-

of-the-science conference statement: Preventing Alzheimer's disease and cognitive decline. NIH Consens State Sci Statements 2010;27:1-30.

8. Senanarong V, Harnphadungkit K, Poungvarin N, Vannasaeng S, Chongwisal S, Chakorn T, et al. The dementia and disability project in Thai elderly: rational, design, methodology and early results. BMC Neurol 2013;13:3.

9. Deetong-on T, Puapornpong P, Pumipichet S, Benyakorn S, Kitporntheranunt M. Prevalence and risk factors of mild cognitive impairment in menopausal women at HRH Princess Maha Chakri Sirindhorn Medical Center. Thai J Obstet Gynaecol 2013;21:110-6.

10. Kengsakul M, Chaikittisilpa S, Hemrungrojn S, Panyakhamlerd K, Jaisamrarn U, Taechakraichana N. The factors associated with mild cognitive impairment (MCI) in surgical menopause women. J Med Assoc Thai 2015;98:327-33.

11. National Health Examination Survey Office (Thailand). Thailand national health and examina-tion survey 2008-2009 [Internet]. 2017 [cited 2016 Jan 5]. Available from: http://ghdx.healthdata.org/record/thailand-national-health-and-examination-survey-2008-2009.

12. Su X, Shang L, Xu Q, Li N, Chen J, Zhang L, et al. Prevalence and predictors of mild cognitive impairment in Xi'an: a community-based study among the elders. PLoS One 2014;9:e83217.

13. Petersen RC, Roberts RO, Knopman DS, Geda YE, Cha RH, Pankratz VS, et al. Prevalence of mild cognitive impairment is higher in men. The Mayo Clinic Study of Aging. Neurology 2010;75:889-97.

14. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Kokmen E, Tangelos EG. Aging, memory, and mild cognitive impairment. Int Psychogeriatr 1997;9 Suppl 1:65-9.

15. Fratiglioni L, Wang HX. Brain reserve hypothesis in dementia. J Alzheimers Dis 2007;12:11-22.

16. Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L, et al. Exercise training increases size of hippocampus and improves memory. Proc Natl Acad Sci U S A 2011;108:3017-22.

17. Mortimer JA, Ding D, Borenstein AR, DeCarli C, Guo Q, Wu Y, et al. Changes in brain volume and cognition in a randomized trial of exercise and social interaction in a community-based sample of non-demented Chinese elders. J Alzheimers Dis 2012;30:757-66.

18. Kramer AF, Erickson KI. Effects of physical activity on cognition, well-being, and brain: human interventions. Alzheimers Dement 2007; 3(2 Suppl):S45-51.

19. Yiengprugsawan V, Khamman S, Seubsman SA, Lim LL, Sleigh AC. Social capital and health in a national cohort of 82,482 Open University adults in Thailand. J Health Psychol 2011;16:632-42.

20. Seeman TE, Lusignolo TM, Albert M, Berkman L. Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur studies of successful aging. Health Psychol 2001;20:243-55.

21. Seubsman SA, Kelly MJ, Yiengprugsawan V, Sleigh AC. Gender, socioeconomic status, and self-rated health in a transitional middle-income setting: evidence from Thailand. Asia Pac J Public Health 2011;23:754-65.

22. Benyamini Y, Idler EL. Community studies reporting association between self-rated health and mortality: additional studies, 1995 to 1998. Res Aging 1999;21:392-401.

23. Jirapramukpitak T, Abas M, Tangchonlatip K, Punpuing S. The effect of asset-based wealth inequality on problem drinking among rural Thai elders: a prospective population-based cohort study. Soc Sci Med 2014;100:107-14.

24. Ward A, Arrighi HM, Michels S, Cedarbaum JM. Mild cognitive impairment: disparity of incidence and prevalence estimates. Alzheimers Dement 2012;8:14-21.

25. Caffrey RA. Family care of the elderly in North-east Thailand: Changing patterns. J Cross Cult Gerontol 1992;7:105-16.