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Hypertension, diabetes and cognitive impairment among elderly

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ABSTRACT

Though the most commonly known risk factor of cognitive impairment is advancing age, hypertension and diabetes are often associated with the acceleration of cognitive decline. This study aimed to identify the relationship of these conditions with cognitive impairment among Indonesian elderly. This study was conducted cross-sectionally using data from the fifth wave of Indonesia family life survey (IFLS5). Cognitive impairment was measured through the modified Telephone Interview for Cognitive Status instrument in IFLS5. Hypertension, diabetes, and control variables were obtained from the answers given by the survey respondents. The final model of the multivariate analysis revealed an interaction between chronic diseases and physical activity in affecting the risk of cognitive impairment. The odds of cognitive impairment in physically less active pre-elderly and elderly with only hypertension and only diabetes, compared to those with no history of illness, are 1.14 (95% CI=0.88–1.48) and 2.55 (95% CI=1.04–6.26) respectively. These results suggested that increasing physical activity can help to reduce the risk of cognitive impairment in elderly, as well as pre-elderly, with hypertension, diabetes, or both conditions. Further longitudinal studies are needed to clarify the causal relationship.

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1. INTRODUCTION

The increasing number of older adults in many countries, including Indonesia, inflicts various public health issues in which one of them is cognitive impairment. Centers for Disease Control and Prevention (CDC) [1] defined cognitive impairment as a condition where an individual has problems remembering, concentrating, or making decisions that could alter their daily activity. Some of the signs and symptoms that are commonly experienced by people with cognitive impairment range from losing certain memory, repeating the same questions or stories over and over, experiencing disorientation towards people, places, or times, to experiencing changes in emotion or behavior [1]. These signs and symptoms are often ignored as most people consider them as a part of the aging process (normal aging). Whereas some references mentioned cognitive impairment as a preclinical stage of dementia or a stage between normal cognitive function and dementia [2]–[4].

Dementia is a chronic or progressive syndrome that should be considered as a public health priority as it is one of the major causes of disability and dependency in the older population around the world [5]. It is estimated that almost 50 million people worldwide lived with dementia in 2015, where people from low-middle-income countries dominated the population with a percentage of 58% [6]. It is projected to rise to 63% (38.53 million) in 2030 and 68% (67.18 million) in 2050 [7]. Several studies have been conducted around the world to identify which factors can delay the onset of dementia, and which one can accelerate the

onset. However, inconsistency is often seen between the results of one study and another due to various factors such as inadequate samples that cannot represent the entire population, as well as different approaches in diagnosing dementia or cognitive impairment [7]–[10].

Previous studies showed strong but not conclusive associations between diabetes and dementia where people with diabetes appear to have lower cognitive performance a and higher risk of dementia [7]. Findings from previous longitudinal studies also showed that having high systolic blood pressure or a hypertension diagnosis can be associated with worse cognitive performance in later life [8]. Identifying the association of cognitive impairment with these chronic conditions became interesting, as previous evidence found controlling hypertension may reduce the risk of cognitive decline [11].

Data in Indonesia reported hypertension as the most common condition among older adults, followed by dental and oral problems, joint disease, diabetes mellitus, and stroke [12]. In 2018, the prevalence of hypertension was 55.2% in pre-elderly and elderly aged 55–64 years, 63.2% in 65–74 years old elderly, and 69.5% in elderly aged 75 years or above [12]. These percentages increased from 45.9%, 57.6%, and 63.8% in the same age range in 2013, respectively [13]. The prevalence of diabetes mellitus based on diagnosis, on the other hand, reached 6.3% in pre-elderly and elderly aged 55-64 years, 6.0% in 65–74 years old elderly, and 3.3% in elderly aged 75 years or above in 2018 [12].

As the number of diabetes and hypertension in older adults in Indonesia continued to increase, this study thus mainly aimed to identify the association between these two chronic conditions with cognitive impairment in Indonesian elderly. The prevalence of cognitive impairment in Indonesian older adults and other relevant characteristics were also defined within this study.

2. RESEARCH METHOD

2.1. Design and sample

This study was conducted using secondary data, namely the Indonesia family life survey (IFLS). IFLS is a longitudinal or panel survey that measures socioeconomic and health situations in Indonesia. It was first implemented in 1993 (IFLS1), which is represented by the Indonesian population living in 13 out of 27 provinces at that time [14]. The survey was continued in 1997 (IFLS2), 1998 (IFLS2+), 2000 (IFLS3), 2007 (IFLS4), and 2014 (IFLS5). This study, however, was limited to a cross-sectional study, using only the latest data from the fifth wave of Indonesia family life survey (IFLS5). There was a total of 50 148 respondents interviewed during IFLS5, with 8,043 of them aged 50 years or above [14].

The inclusion criterion in this study was elderly, including pre-elderly, aged 50 years or above who completed all questions related to cognitive measurement. Out of 50 148 respondents, 34 265 data were matched after merging. A total of 8,001 respondents met the age criteria (≥50 years), with 6,527 respondents completing the cognitive measurement. IFLS has stratified the respondents by province and other demographical factors [15]. In this study, cross-sectional weight with attrition was used so that the samples represented the Indonesian population in 2014.

2.2. Variables

2.2.1. Cognitive impairment

Ranging from 0 to 27, cognitive scores were classified into cognitive impairment and normal cognitive. Pre-elderly and elderly were classified as cognitive impairment if they scored less than 12. The scores were extracted from the subtraction series, word recall, and backward counting questions of the IFLS-modified telephone interview for cognitive status (TICS). A similar approach has been applied in previous studies where better cognitive functions were represented by higher scores [16]–[20].

2.2.2. Chronic conditions: hypertension and diabetes

In this study, samples were classified into normal conditions (no hypertension or diabetes), only hypertension, only diabetes, and living with both conditions (hypertension and diabetes). Hypertension was defined from respondents' answers during the IFLS5 survey, which was then compared to the average of their blood pressure measurement (if any). Diabetes in this study was also defined from respondents' answers during the IFLS5 survey, which was then compared to their HbA1c level measurement (if any). Samples were classified as 'normal' if they answered no to both 'have a health practitioner ever told you that you had hypertension' and 'have a health practitioner ever told you that you had diabetes' questions. They classified as having both hypertension and diabetes if they answered yes to both questions.

2.2.3. Other control variables

The control variables in this study included demographic factors (age, gender, and education background) and lifestyle factors (smoking status and physical activity). All demographic factors were

defined from the respondent's answer during IFLS5. The age was classified into four categories, including pre-elderly for respondents aged 50–59 years, youngest-old for respondents aged 60–69 years, middle-old for respondents aged 70–79 years, and oldest-old for those aged 80 years or above. Education background was categorized into three groups: high level of education, medium level of education, and low level of education.

Physical activities were defined from respondents' responses to 'different types of physical activities in the last seven days' questions. Respondents were classified as 'physically active' if they did any vigorous activities, or any moderate physical effort, or a combination of any type of physical activities, for at least 10 minutes continuously during the last seven days from the interview. They were classified as 'physically less active' if they were only walking or mobilizing from one place to another, or if they did not do any type of physical activities for at least 10 minutes continuously. In this study, pre-elderly and elderly were categorized as non-smoker, ex-smoker, and active smoker for smoking status.

2.3. Data analysis

All data were analyzed using Stata 14.1. After being analyzed descriptively, multivariable associations were performed to identify the relationship of chronic conditions (diabetes and hypertension) with cognitive impairment. The four stages of survey data logistic regression modeling, including: i) model specification, ii) model estimation, iii) model evaluation, and iv) interpretation were applied as recommended by Hosmer and Lemeshow [21], [22].

2.4. Research ethics

The series of Indonesia family life survey has gone through ethical review procedures approved by the institutional review boards (IRBs) in the United States (RAND) and in Indonesia (Universitas Indonesia for IFLS1 and IFLS2; and Universitas Gadjah Mada for IFLS3, IFLS4, and IFLS5) [14]. The IRB in Indonesia for IFLS5 was associated with Survey Meter [14].

Specifically for this secondary or follow-up study, a request for an ethical review has also been submitted to the Research and Community Engagement Ethical Committee of the Faculty of Public Health , Universitas Indonesia. It has been declared eligible to be carried out based on Certificate Number: Ket-284/UN2.F10.D11/PPM.00.02/2020.

3. RESULTS AND DISCUSSION

3.1. Characteristics of Indonesian elderly

Based on the results of descriptive analysis, the pre-elderly population aged 50–59 years dominates the target age group of this study with a percentage of 58.32%, followed by those in the youngest-old category aged 60–69 years, middle-old aged 70–79 years, and oldest-old aged 80 years or above as shown in Table 1. A decrease in percentage in the older age category also reflected life expectancy data from the Central Statistics Agency which only reached 70.59 years in the same period with the fifth Indonesia family life survey (IFLS5) data collection phase in 2014 [23].

In terms of gender and educational history, the pre-elderly and elderly groups are dominated by women and individuals with low levels of education, respectively. In terms of lifestyle, a greater percentage is seen in those who adopt a healthy lifestyle where more physically active and non-smoker pre-elderly and elderly were identified as shown in Table 1.

Regarding the chronic conditions, specifically hypertension, and diabetes, the results of IFLS5 showed that the percentage of hypertension in Indonesian pre-elderly and elderly populations reached 58.42%, while the percentage of pre-elderly and elderly with diabetes in Indonesia reached 9.76%. These proportions were similar to the latest data reported nationally, where the prevalence of hypertension based on blood pressure measurement was ranged from 45.32 to 69.53% in Indonesian pre-elderly and elderly populations [12]. The percentage of diabetes from IFLS5 results also showed a similarity with the latest data reported in Indonesia, which ranged from 11.5 to 15.6% in the same age group [12]. The gap with the national diabetes proportions might be due to different classification approaches, in which IFLS5 has very limited data for HbA1c measurement which were needed for comparison with diabetes classification based on diagnosis from health practitioners in this study.

After combining hypertension and diabetes data, the descriptive analysis showed that 7.44% of pre-elderly and elderly populations aged 50 years or over in Indonesia were living with both hypertension and diabetes at the same time as shown in Table 1. If not properly managed, the burden of hypertension and diabetes might impose a growing burden on health, specifically in older populations [24], [25].

Table 1. Characteristics of Indonesian elderly aged 50 years or over, 2014–2015

Variables	Proportions (%)	Cognitive impairment No (%)	Cognitive impairment Yes (%)	OR (95% CI)	p
Chronic conditions					
Chronic conditions – combined					
No chronic conditions	39.25	49.32	50.68	Reference	
Only hypertension	50.98	46.25	53.75	1.13 (1.01–1.27)	
Only diabetes	2.33	63.05	36.95	0.57 (0.40–0.81)	0.0000
Both hypertension and diabetes	7.44	55.71	44.29	0.77 (0.62–0.96)	
Demographic characteristics					
Age category					
Pre-elderly	58.32	55.11	44.89	Reference	
Youngest-old	29.26	46.90	53.10	1.39 (1.23–1.57)	
Middle-old	10.52	24.25	75.75	3.83 (3.17–4.63)	0.0000
Oldest-old	1.90	7.00	93.00	16.32 (8.08–32.92)	
Gender					
Male	49.48	52.82	47.18	Reference	
Female	50.52	44.37	55.63	1.40 (1.26–1.56)	0.0000
Education background					
High level of education	17.42	84.35	15.65	Reference	
Medium level of education	33.48	61.53	38.47	3.37 (2.79–4.07)	0.0000
Low level of education	49.10	27.00	73.00	14.58 (12.10–17.56)	
Lifestyle					
Smoking status					
Non-smoker	56.46	47.61	52.39	Reference	
Ex-smoker	8.95	53.68	46.32	0.78 (0.65–0.95)	0.0432
Active smoker	34.95	48.75	51.25	0.96 (0.85–1.07)	
Physical activity					
Active	58.75	51.01	48.99	Reference	
Less-active	41.25	45.05	54.95	1.27 (1.14–1.41)	0.0000
Total percentage of cognitive impairment	100.0	48.55	51.45		

The descriptive analysis results also showed that the total percentage of cognitive impairment in Indonesian pre-elderly and elderly populations reaches 51.45%, or higher than those without cognitive impairment as shown in Table 2. Based on the bivariate analysis or model specification, aside from advancing age, female pre-elderly and elderly, those with a low level of education, and those with less physical activity were having a higher proportion of cognitive impairment. In this initial analysis, pre-elderly and elderly with only hypertension were having a higher risk of experiencing cognitive impairment. This needs to be further clarified with multivariable analysis (Section 3.2).

Among the 51.45% pre-elderly and elderly with cognitive impairment, 33.57% scored lower than seven which can be categorized as having severe cognitive impairment, or often interchangeably defined as dementia, based on previous literature [18], [19]. People living with severe cognitive impairment tend to have a higher risk of losing the ability to perform activity of daily living (ADL), or the ability to live independently [1], [26], [27]. Although this study did not measure ADL function in Indonesian pre-elderly and elderly, follow-up studies related to the effect of cognitive impairment on ADL function were recommended, considering the availability of its instrument in the IFLS questionnaire.

Apart from the proportion of severe cognitive impairment and other types of cognitive impairment in Indonesian pre-elderly and elderly, the percentage of cognitive impairment in general in this population was higher than the percentage in other countries worldwide. A population-based study in South Korea, which currently experiencing the phenomenon of population aging, showed lower percentages ranging from 5.0-8.1% for dementia and 24.1-27.0% for cognitive impairment in elderly aged 65 years or above [28], [29]. Compared to Germany as one out of ten countries with the highest prevalence of dementia worldwide, the percentage of severe cognitive impairment in Indonesia was similar [30], [31]. The high percentage might also be influenced by different approaches of cognitive impairment measurement, and the national data quality itself. However, compared to the results of a similar study with a similar approach in the United States, the percentage of cognitive impairment in Indonesia was still 3–4 times higher [17].

3.2. Chronic conditions and cognitive impairment in Indonesian elderly

Analyzed with the four stages of the Hosmer and Lemeshow approach, age categories, education background, and physical activity were identified as the confounders in the relationship of chronic conditions with cognitive impairment. Gender and smoking status were not included in the final model as they did not contribute significantly to the relationship between chronic conditions (hypertension and diabetes) with cognitive impairment. The final model of the multivariate analysis can be seen in Table 2.

Table 2. Final model of chronic conditions association with cognitive impairment among Indonesian elderly aged 50 years or over, 2014–2015

Variables	OR	SE	95% Confidence interval		p
			Lower	Upper	
Chronic conditions – combined					
No chronic conditions	Reference				
Only hypertension	0.95	0.0813	0.80	1.13	0.566
Only diabetes	0.45	0.1625	0.22	0.91	0.027
Both hypertension and diabetes	0.69	0.1268	0.48	0.99	0.043
Age category					
Pre-elderly	Reference				
Youngest-old	1.32	0.0910	1.15	1.51	0.000
Middle-old	3.14	0.3385	2.54	3.88	0.000
Oldest-old	11.12	3.9572	5.53	22.34	0.000
Education background					
High level of education	Reference				
Medium level of education	3.32	0.3277	2.74	4.03	0.000
Low level of education	13.54	1.3055	11.21	16.36	0.000
Physical activity					
Active	Reference				
Less-active	1.02	0.1036	0.83	1.24	0.867
Chronic disease*physical activity					
Hypertension*Less-active	1.14	0.1514	0.88	1.48	0.317
Diabetes*Less-active	2.55	1.1683	1.04	6.26	0.040
Both hypertension and diabetes*Less-active	1.73	0.4434	1.05	2.86	0.031

The final model of the multivariate analysis revealed an interaction between chronic diseases and physical activity in affecting the risk of experiencing cognitive impairment among Indonesian pre-elderly and elderly as shown in Table 2. Previously, Iadecola *et al.* [8] have mentioned the possibility of interaction between chronic disease and other factors, specifically age, menopausal status for women, and others. A previous population-based longitudinal study has proven the interaction between hypertension and age where developing hypertension at older ages may protect against dementia [32]. The interaction of chronic conditions and age could not be considered in this study due to the limitations of pre-elderly and elderly who only had diabetes, as well as diabetes and hypertension as shown in Table 1, as opposed to chronic conditions and physical activity.

In this study, the odds ratio of cognitive impairment in pre-elderly and elderly with hypertension and less physical activity was 1.14 (95% CI=0.88–1.48) compared to those with no history of illness as shown in Table 2. Pre-elderly and elderly with diabetes who are physically less active tended to have a higher risk of experiencing cognitive impairment compared to those with no history of illness (OR=2.55, 95% CI=1.04–6.26). Tantamount to the previous one, the odds ratio of cognitive impairment in physically less active pre-elderly and elderly with both hypertension and diabetes was 1.73 (95% CI=1.05–2.86) compared to those with no history of illness.

Similar cross-sectional studies linked high blood pressure, hypertension, and uncontrolled blood pressure with poorer cognitive function than the normal condition [33], [34]. Several literatures have mentioned how hypertension during aging may cause vascular remodeling and stiffening, resulting in reduced cerebral blood flow (CBF) and cerebral hypoperfusion that may subsequently lead to cognitive impairment [8], [35], [36]. According to the previous studies, cognitive domains that experienced the most decline include memory, attention, executive function, and processing speed [8], [37]. In this study, the memory domain was represented by the immediate and delayed word recall questions in the IFLS-modified TICS instrument, while attention was represented by the subtraction series questions and processing speed was represented by counting backward questions. In diabetic patients, poorer cognitive functions have been associated with poor glycemic control, duration of diabetes, as well as other microvascular complications where the most affected cognitive domains also include psychomotor efficiency and verbal fluency and learning, other than attention, executive function, and processing speed [38], [39].

The interaction between chronic disease and physical activity, on the other hand, was also identified through a similar study from Frith and Loprinzi [40]. It was concluded that hypertensive older adults meeting the minimum physical activity recommendations of 500 metabolic-equivalent task/min-week or 150 minutes of moderate-to-vigorous activity/week was associated with higher cognitive function, compared to the inactive participants. In our study, diabetic and hypertensive pre-elderly and elderly who did not do any vigorous or moderate activity for at least 10 minutes continuously during the last seven days from the IFLS interview or regularly tended to have a higher risk of experiencing cognitive impairment compared to those without a history of hypertension, diabetes, or both. Vigorous activities addressed in the IFLS questionnaire include heavy lifting, aerobics, or fast bicycling. Meanwhile, carrying light loads, bicycling at a regular pace,

and other similar activities were categorized as moderate physical efforts [14], [41]. A previous trial has reported that after six months of regular exercise program consisting of 90 minutes/week activity, both immediate memory and delayed recall function in individuals aged 65 years and over were improved [42], [43].

Whilst explaining the mechanism of how physical activity can reduce the risks of cognitive impairment in older adults with chronic conditions was beyond the scope of this study, a previous study has stated how neuroprotective and neurorestorative benefits of exercise are potentially capable of reducing neurodegenerative risks [40]. Physical activity is also commonly known to be one of the protective factors of various chronic conditions, also dementia, and cognitive impairment [3], [42], [44], [45]. Though this might be linked with the study results, further experimental studies were still needed to explore the mechanisms.

3.3. Study limitations

Data availability became one of the main limitations and challenges in this study. Conducted using secondary data, researchers have no control over the data collection process, as well as the completeness of research data. The cognitive impairment variable in this study was measured with the modified version of telephone interview for cognitive status (TICS). In which, only certain cognitive domains were measured while the other measurements were omitted due to inadequate questions within the instrument. It is important to note that the use of a similar modified TICS instrument, which was applied in a previous study with Langa and Weir approach, only has a sensitivity rate of 74% in predicting cognitive impairment and 78% in predicting dementia [17], [18]. Therefore, measurement bias might be present as well in the results of this study.

Further follow-up studies using primary data or adding more components to the modified instrument are highly recommended to increase the accuracy in estimating the proportions of cognitive impairment among pre-elderly and elderly in Indonesia. It is expected that in the future, Indonesia can also consider nationwide cognitive measurement through the Indonesia Demographic Health Survey with other gold-standard instruments, such as Mini-Mental State Examination, as a comparison to the current IFLS-modified TICS.

Other than the completeness of research data and different approaches of cognitive assessment, cross-sectional design also became a limitation in this study. Previous cross-sectional studies on the relationship of chronic disease with cognitive impairment showed some inconsistency as the design could not capture the causal relationship, nor temporal association between a putative exposure and outcome [8]. A follow-up study with longitudinal design is also recommended to clarify other factors that can be modified or intervened to delay the onset of cognitive impairment or other types of dementia in pre-elderly and elderly in Indonesia.

4. CONCLUSION

The study found that there is an influence of physical activity in the association of chronic conditions with cognitive impairment. Indonesian pre-elderly and elderly aged 50 years or above, specifically those who are physically less active and living with hypertension, diabetes, or both, are more likely to experience cognitive impairment as they advance in age, compared to those with no history of illness. Notwithstanding that further longitudinal study still needs to be done to clarify the causal relationship, the results of this study also reflect the importance of other modifiable factors in affecting cognitive impairment in older adults with hypertension, diabetes, or both conditions. Interaction analysis with other variables that determine chronic conditions in elderly is strongly recommended to further clarify the relationship. Identifying other modifiable factors would also be crucial in developing elderly health programs in the future, specifically those that can reduce the risks or delay the onset of cognitive impairment.

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