ORIGINAL ARTICLE

The Differences in Risk Factors for Cognitive Function Disorders among Indonesian Elderly in Urban and Rural Areas

Nunung Cipta Dainy[1], Fauza Rizqiya[1], Ika Puspa Windardi[2]

[1] Nutrition Study Program, Faculty of Medicine and Health, Universitas Muhammadiyah Jakarta, Jakarta, Indonesia, 10510
[2] Nutrition Department, Universitas Muhammadiyah Bogor Raya, Bogor, West Java, Indonesia 16640

ABSTRACT

Introduction: The prevalence of Alzheimer's disease is rising alongside an ageing population. However, many still perceive Alzheimer's as a natural part of ageing, which could impede efforts to capitalize on the demographic dividend. Research on Alzheimer's risk factors in Indonesia is underdeveloped, making it challenging to identify the leading causes across the country's diverse ethnic and cultural groups. This study aims to identify risk factors for cognitive impairment among the elderly in rural and urban areas. **Methods:** We conducted this cross-sectional study from May to June 2024 in Leuwiliang District, Bogor, Indonesia, and Mampang Prapatan District, South Jakarta, Indonesia. Data collected included subject characteristics, nutrition, blood pressure, blood glucose, nutritional status, mental health, and physical activity. Stratified random sampling selected a total of 132 elderly individuals from both areas based on the inclusion criteria: aged 60–80, able to count simply, and independent in daily activities. We performed statistical analysis using the chi-square test at a 95% confidence level. **Results:** The results showed that educational level was associated with cognitive impairment in both regions (p-value <0.05). Ethnicity links to cognitive impairment in rural (p-value <0.05), not urban elderly. Additionally, a significant relationship between blood pressure and mental health with cognitive impairment was found among the elderly in urban areas (p-value <0.05) but not in rural areas. **Conclusion:** In conclusion, differences in risk factors for cognitive impairment were observed between urban and rural areas, specifically blood pressure and mental health, with educational level being a common factor.
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Corresponding Author:
Nunung Cipta Dainy, PhD
Email: nciptadainy@umj.ac.id
Tel : +6281399287143

INTRODUCTION

The 2022 Elderly Population Statistics project that by 2030, at least 1 in 6 individuals globally will be elderly, signifying a substantial rise in the senior demographic worldwide. In 2015, individuals aged 60 and older made up 12.3% of the global population, and by 2050, this figure is projected to rise to nearly 22% (1). The percentage of elderly Indonesians has increased by at least 4 percent over the past decade (2010-2022), reaching 11.75%(1). This indicates that the elderly demographic in Indonesia is persistently increasing. This occurrence may be regarded as a second demographic dividend if the elderly maintain productivity and contribute to the nation's economy. The elderly reliance ratio is 16.09, indicating that almost six working-age individuals assist each senior adult. The population of elderly women exceeds that of men, with a ratio of approximately 52.28% women to 48.19% men. More than 50% of the elderly population resides in urban areas (1).

Cognitive alterations are a crucial facet of the ageing process and can influence the autonomy and daily functions of the aged. Cognitive alterations linked to ageing encompass a deterioration in memory function, diminished problem-solving capabilities, less attention and concentration, slower information processing, and a fall in language proficiency. These alterations, while typical in the ageing process, may be more pronounced in certain elderly individuals, resulting in cognitive deficits such as dementia. Dementia is a neurological disorder that results in considerable cognitive deterioration, manifesting as memory deficits, comprehension difficulties, and disorientation (2)

The 2017 Lancet Commission identifies several risk factors associated with cognitive decline and dementia in the elderly, including smoking, depression, social disengagement, physical inactivity, diabetes, and air pollution (2). A study identified age, educational attainment, and social engagement as risk factors for

dementia in the elderly (3)The risk factors for dementia may differ across urban and rural regions. Disparities in the attributes of urban and rural populations may emerge from differing environments and circumstances. Rural regions are mostly agricultural communities, whereas urban regions are industrial societies (4) Rural regions, possessing comparatively superior air quality versus urban locales, may encounter varying levels of stress. Enhanced transport infrastructure in urban regions influences disparities in physical activity levels between urban and rural populations. The individualistic social environment in urban regions contributes to the disparities in social activities between urban and rural groups (4) This study aims to identify risk factors for cognitive impairment among the elderly in rural and urban areas.

MATERIALS AND METHODS

This study was observational research that used a cross-sectional study design and was conducted in two regions. The investigation was conducted between April and June of 2024. The investigation was employed at elderly integrated health service posts (Posbindu) in both urban and rural areas. The urban area is located in Mampang Prapatan District, South Jakarta, Indonesia, while the rural region is located in Leuwimekar Village, Leuwiliang District, Bogor Regency, West Java, Indonesia.

The research sample was selected by stratified random sampling based on inclusion criteria, specifically men and women aged 60 to 80 who engage in everyday activities autonomously. The computation of the minimum sample size was conducted utilizing a sample size calculator for comparative studies with a cross-sectional design from the software sampsize. sourceforge.net. The percentage values for proportion 1 (p1)(5) and proportion 2 (p2)(6)regarding the researched variables were entered into the software. With a power of 90% and an alpha of 5%, the minimum necessary sample size was 66 individuals each area, resulting in a total of 132 elderly.

Research instruments

The dependent variable in this study was cognitive function in the elderly, while the independent variables were age, gender, education, occupation, ethnicity, nutritional intake, nutritional status, physical activity, blood pressure, blood glucose levels, and mental health. The research instruments used included a socio-demographic questionnaire, a 24-hour Food Recall questionnaire, the Physical Activity Scale for the Elderly (PASE) questionnaire, the Geriatric Depression Scale (GDS) questionnaire, and the Short Portable Mental Status Questionnaire (SPMSQ). PASE, GDS, and SPMSQ are standardized questionnaires that have undergone validity and reliability testing in Indonesia(7–9). The equipment used included an OMRON® digital body scale, a SAGA® stadiometer, an OMRON® digital blood pressure monitor, and the Easy Touch® GCU for measuring random blood glucose levels.

The data for the independent and dependent variables was categorized based on their respective cut-off points. Cognitive function data was categorized into two categories: cognitive impairment (SPMSQ score ≥4) and normal cognitive function (SPMSQ score <4). Nutritional status data based on Body Mass Index (BMI) was categorized into two categories: malnutrition (18.5> BMI ≥25) and normal (18.5≤ BMI <25). Physical activity data was categorized into two categories: sedentary (PASE score <125) and active (PASE score ≥125). Nutritional intake data, consisting of energy intake and macronutrients (carbohydrates, fats, and proteins), were categorized into two categories: adequate intake (≥80% RDA) and inadequate intake (<80% RDA). Mental health data was categorized into three categories: severe depression (GDS score ≥12), mild depression (GDS score 5 – 11), and normal (GDS score ≤4). Blood glucose level data was categorized into two categories: normal (<200 mg/dl) and hyperglycemia (≥200 mg/dl). Blood pressure data was categorized into two categories: normal (<140/90 mmHg) and hypertension (≥140/90 mmHg) (10).

Data analysis

The data collected from interviews and measurements was organised, averaged, and subsequently analysed descriptively to examine the univariate characteristics of variables including nutritional status, nutrient intake, social activity, physical activity, depression levels, blood glucose levels, blood pressure, and cognitive function. The correlation between the dependent and independent variables of each location was analysed using the Chi-Square test with SPSS 16 for Windows. If the p-value was <0.05, the independent variable was considered to be a significant risk factor for cognitive function impairment.

Ethical Clearance

The Health Research Ethics Committee of Mataram Health Polytechnic granted ethical approval with the reference number LB.01.03/6/171/2024.

RESULTS

The study subject consisted of 66 individuals from rural areas and 66 from urban areas. Table I delineates the general features of the subjects in this investigation. A majority of subject in rural areas (71.9%) with cognitive impairment were aged 65-80 years, while approximately 80% of subjects aged 60-64.9 years in urban areas exhibited normal cognitive function. The proportion of female subjects exhibiting cognitive impairment in rural areas was greater (74.1%) than in urban areas (23.8%). Individuals with low educational attainment exhibiting cognitive impairment in rural

Table I. General Characteristics of Subject

Characteristics	Rural				Urban			
	Cognitive Impairment n (%)	Normal Cognitive Function n (%)	p value	OR (95%CI)	Cognitive Impairment n (%)	Normal Cognitive Function n (%)	p value	OR (95%CI)
Age								
65.0-80.0 year	23 (71.9)	9 (28.1)	0.709	1.222 (0.426-3.505)	11 (40.7)	16 (59.3)	0.740	2.664 (0.894-7.943)
60.0-64.9 year	23 (67.6)	11 (32.4)			8 (20.5)	31 (79.5)		
Sex			0.101	0.350 (0.097-1.265)			0.237	1.920 (0.646-5.708)
Male	6 (50.0)	6 (50.0)			9 (37.5)	15 (62.5)		
Female	40 (74.1)	14 (25.9)			10 (23.8)	32 (76.2)		
Education			0.042*	-			0.025*	-
Low	42 (70.0)	18 (30.0)			15 (42.9)	20 (57.1)		
Moderate	4 (100.0)	0 (0.0)			4 (13.8)	25 (86.2)		
High	0 (0.0)	2 (100.0)			0 (0.0)	2 (100.0)		
Occupation			0.298	0.517 (0.147-1.816)			0.355	1.738 (0.535-5.647)
Unemployed	31 (66.0)	16 (34.0)			14 (32.6)	29 (67.4)		
Employed/Retired	15 (78.9)	4 (21.1)			5 (21.7)	18 (78.3)		
Ethnicity			0.029*	-			0.061	-
Sundanese	46 (71.9)	18 (28.1)			0 (0.0)	5 (100.0)		
Betawi	0 (0.0)	2 (100.0)			15 (39.5)	23 (60.5)		
Others	0 (0.0)	0 (0.0)			4 (17.4)	19 (82.6)		

* Significant at $\alpha < 0.05$ with Pearson Chi Square Test

and urban regions were 70% and 42.9%, respectively. In rural areas, 66% of unemployed subjects exhibited cognitive impairment, whereas in urban areas, the figure was 32.6%. In rural regions inhabited by the Sundanese ethnic group, 71.9% exhibited cognitive impairment. Simultaneously, 39.5% of the Betawi ethnic group and 17.4% of other ethnic groups in urban settings exhibited cognitive impairment. There is no association between age groups and participants' cognitive function in rural and urban settings, with significance values of p=0.709 and p=0.740, respectively.

Table II highlights the correlation between nutrient intake and cognitive impairment. The energy and macronutrient intake of subjects in both regions did not show a significant correlation with the incidence of cognitive impairment in the elderly.

Table III shows the correlation among health status indicators, encompassing blood pressure, random blood glucose, nutritional status, mental health, physical activity, and cognitive function impairment. The research indicates that in rural areas, no characteristics correlate with cognitive impairment in the elderly. In urban areas, blood pressure and mental health factors have a significant association with cognitive function impairment. In the comparison of proportions, individuals in rural areas exhibit a greater prevalence of cognitive impairment across all health indicators, hence indicating no statistically significant relationship.

DISCUSSION

Elderly Characteristics in Rural and Urban Areas in Relation to Cognitive Impairment This study demonstrated no significant correlation between age, gender, and employment status with the cognitive function of the elderly in rural and urban regions. The risk variables affecting cognitive function in the elderly are education and ethnicity in rural areas, whereas in urban areas, only education is a concern. No correlation exists between age groups and cognitive performance among people in rural and urban settings, which contradicts recent research indicating that persons aged > 65 years have a 2.520-fold increased risk of acquiring dementia compared to those aged 60-64 years (11). A study involving older adults in Malang City, East Java, Indonesia, identified a correlation between age and cognitive function with a p-value of 0.004(12) However, a study involving elderly women aged 60 to 82 years at a nursing home in Bogor, Indonesia, revealed no significant correlation between the subjects' age and the prevalence of dementia (p>0.05)(13). Numerous factors may cause age to not have a direct correlation with cognitive function. Education, physical activity, socioeconomic status, and social involvement may have a more crucial role in preserving cognitive function, even at advanced age (14).

Table II. Nutrient Intake of Subjects

Nutrient Intake	Rural (%)				Urban (%)			
	Cognitive Impairment n (%)	Normal Cognitive Function n (%)	p value	OR (95%CI)	Cognitive Impairment n (%)	Normal Cognitive Function n (%)	p value	OR (95%CI)
Energy			0.907				0.264	
Deficient	44 (69.8)	19 (30.2)		1.158 (0.099-13.553)	15 (26.3)	42 (73.7)		0.446 (0.106-1.886)
Adequate	2 (66.7)	1 (33.3)			4 (44.4)	5 (55.6)		
Carbohydrate			0.602				0.860	
Deficient	42 (68.9)	19 (31.1)		0.553 (0.058-5.282)	15 (28.3)	38 (71.7)		0.888 (0.237- 3.327)
Adequate	4 (80.0)	1 (20.0)			4 (30.8)	9 (69.2)		
Protein			0.376				0.640	
Deficient	44 (71.0)	18 (29.0)		2.444 (0.319-18.709)	17 (29.8)	40 (70.2)		1.488 (0.280-7.908)
Adequate	2 (50.0)	2 (50.0)			2 (22.2)	7 (77.8)		
Fat			0.811				0.749	
Deficient	38 (69.1)	17 (30.9)		0.838 (0.198-3.555)	16 (29.6)	38 (70.4)		1.263 (0.302-5.285)
Adequate	8 (72.7)	3 (27.3)			3 (25.0)	9 (75.0)		

Table III. Health Status and Physical Activity Variables

Health variable	Rural (%)				Urban (%)			
	Cognitive Impairment n (%)	Normal Cognitive Function n (%)	p value	OR (95%CI)	Cognitive Impairment n (%)	Normal Cognitive Function n (%)	p value	OR (95%CI)
Blood Pressure			0.206	0.474 (0.147-1.526)			0.008*	5.565 (1.429-21.667)
Hypertension	27 (64.3)	15 (35.7)			16 (41.0)	23 (59.0)		
Normal	19 (79.2)	5 (20.8)			3 (11.1)	24 (88.9)		
Blood Glucose Level			0.338	2.189 (0.428-11.200)			0.989	0.988 (0.175-5.596)
Hyperglycemic	9 (81.8)	2 (18.2)			2 (28.6)	5 (71.4)		
Normal	37 (67.3)	18 (32.7)			17 (28.8)	42 (71.2)		
Nutritional Status			0.921	1.056 (0.362-3.077)			0.912	1.064 (0.353-3.203)
Malnutrition	19 (70.4)	8 (29.6)			12 (29.3)	29 (70.7)		
Normal	27 (69.2)	12 (30.8)			7 (28.0)	18 (72.0)		
Mental Health			0.142	3.176 (0.639-15.768)			0.017*	4.156 (1.234-13.994)
Mild Depression	12 (85.7)	2 (14.3)			8 (53.3)	7 (46.7)		
Normal	34 (65.4)	18 (34.6)			11 (21.6)	40 (78.4)		
Physical Activity			0.353	1.762 (0.530-5.863)			0.947	0.960 (0.285- 3.231)
Sedentary	37 (72.5)	14 (27.5)			14 (28.6)	35 (71.4)		
Active	9 (60.0)	6 (40.0)			5 (29.4)	12 (70.6)		

* Significant at $\alpha < 0.05$ with Pearson chi square test

There is no correlation between gender and cognitive impairment in both rural and urban populations, with p-values of 0.101 and 0.237, respectively. A study conducted in Padang Panjang, West Sumatra, Indonesia, revealed no significant correlation between gender and cognitive function (p=0.100) (15). Their data suggest that the prevalence of cognitive impairment increases with age, with women being at greater risk than men due to their longer life expectancy. This study found that older women in rural regions tend to experience greater cognitive decline than their urban counterparts. This is related to the limited social engagement undertaken by older women in rural areas. Conversely, the social engagement of most elderly women in urban areas is more diverse (16). The activities undertaken by the elderly influence their psychological state, which may subsequently affect their cognitive function.

Table I indicates that all individuals with higher education levels, regardless of rural or urban settings, exhibit normal cognitive function (100%). A notable correlation exists between educational level and cognitive function among subjects in both rural and urban settings. The same observation was also noted among the elderly in several cities in Indonesia, showing a strong correlation between education level and cognitive function decline (p>0.05) (17). A systematic review indicated that higher educational attainment correlates with a reduced risk

of developing Alzheimer's disease (18). Consequently, the more often someone engages their brain, the more gradual the deterioration in cognitive performance. Education enriches life experiences and intellectual engagement, thereby influencing an individual's cognitive abilities.

This study found no significant correlation between employment status and cognitive function among subjects in both rural and urban settings. The majority of elderly individuals in rural Indonesia are not employed, primarily due to age, physical constraints, and insufficient educational attainment. In urban settings, older individuals often have greater opportunities for employment, despite many being at retirement age. Nevertheless, higher educational attainment, better access to healthcare services, and a broader range of employment opportunities may make elderly individuals in urban areas more economically engaged than their rural counterparts.

There is a relationship between ethnicity and cognitive performance among individuals in rural settings. A prior study elucidated various risk factors for cognitive decline, including race and ethnicity. All Betawi ethnic individuals in rural regions exhibit normal cognitive function, while all Sundanese ethnic individuals in urban areas have normal cognitive function. The study's results indicate that individuals of ethnicities not native to their residential regions exhibited normal cognitive performance. The results of another study showed that Javanese individuals in the North Sumatra region demonstrated a higher level of independence (48%) compared to the Batak ethnicity, which is the indigenous population(19) This discovery pertains to demography, societal conditions, and the autonomy of the elderly(20)
Elderly Energy and Macronutrient Intake in Rural and Urban Areas in Relation to Cognitive Impairment
Nutrient intake in this study has no association with cognitive function. Prior research has indicated that high caloric consumption may elevate oxidative damage and amyloid deposition, harming neuronal cells and increasing the likelihood of cognitive decline(21) Energy is vital for living beings to sustain critical physiological functions and is closely linked to cognitive function(22). The individuals' protein consumption does not show a significant correlation with the incidence of cognitive impairment in the elderly. Protein contributes to brain development and the production of neurotransmitters. A shortage of protein can hinder the synthesis of neurotransmitters essential for neuronal communication, ultimately affecting cognitive function (23). One study indicated that a reduction in protein intake increases the likelihood of cognitive decline (24) Individuals with cognitive impairment exhibited lower protein consumption compared to healthy individuals(25). Meanwhile, increased dietary protein consumption is associated with enhanced cognitive performance(22).
The carbohydrate consumption of subject does not exhibit a significant correlation with the incidence of cognitive impairment in the elderly. Individuals with cognitive impairment in urban settings typically exhibit lower carbohydrate consumption compared to their rural counterparts. Carbohydrates are nutrients that supply glucose to the neurological system. Excess glucose induces elevated blood glucose levels, heightening oxidative stress and resulting in cognitive impairment(26) The other studies indicate that high carbohydrate consumption correlates favorably with cognitive impairment (27).

Elderly Health Status and Physical Activity in Rural and Urban Areas in Relation to Cognitive Impairment
The prevalence of hypertension in this study (61.4%) significantly exceeds the national prevalence of hypertension, which is 34.11%(28) A study conducted in Medan, North Sumatra, Indonesia, demonstrated a correlation between blood pressure and cognitive impairment in the elderly, with a p-value of 0.003(29) Hypertension can induce ischemia and hemorrhage in the brain, both acutely and chronically, potentially damaging brain tissue and leading to cognitive impairment and significant neurocognitive disorders(30,31). Hypertension is a controllable risk factor for cognitive decline. Intervention studies employing randomized controlled trial designs indicate a 7-11% relative risk decrease in the incidence of dementia with antihypertensive treatment (30,32).

The findings in urban settings indicate a significant relationship between mental health and educational attainment with cognitive function impairment. The prevalence of depression in rural populations (21.2%) is comparable to that in urban populations (22.7%). The prevalence rate is slightly greater than another study's findings, which indicated a depression prevalence of 16.3% among the elderly in Indonesia(33) and above the national prevalence of mental disorders at 9.8%(28) Depression in the elderly is associated with cognitive impairment, with severely depressed elderly adults being twice as likely to develop cognitive dysfunction(34). Factors contributing to the vulnerability of older adults in urban areas to depression include gender, chronic disease history, education, employment status, marital status, and physical activity(35). Furthermore, depression among the elderly is attributed to diminished life satisfaction and perceived inadequate health (33).

The findings of this study are consistent with current evidence showing that cognitive decline among the elderly is influenced by a combination of social, psychological, and physical health factors rather than age alone. Hypertension has been shown to impair cognitive function through indirect pathways such as poor sleep quality and depressive symptoms(36). Education continues to be a key protective factor, as lower educational attainment is associated with a higher risk of dementia and cognitive impairment, particularly

in urban populations(37,38).

Social capital, including emotional support and social engagement, also plays a crucial role in preserving cognitive abilities such as memory and orientation. This is especially relevant for older women in rural areas who face limited opportunities for meaningful social interaction compared to those in urban settings(39). Moreover, national data indicate that depression affects approximately 20.4% of older adults in Indonesia, and is strongly linked to chronic health conditions and socioeconomic challenges (33). These findings highlight the importance of implementing multidisciplinary intervention approaches that integrate health, education, and social support systems to maintain and improve cognitive health among older adults.

CONCLUSION

The educational level features of subjects in both areas revealed a significant relationship with cognitive impairment. Nutritional intake variables exhibit no significant relationship with cognitive impairment in the elderly across both regions. No significant relationship has been observed between the various health status and physical activity factors examined and cognitive function impairment in the elderly residing in rural settings. In urban elderly groups, blood pressure and mental health variables are significant risk factors for cognitive impairment (p-value <0.05). Additional research is required to investigate the causes contributing to hypertension and depression in the elderly across both areas, which generate varying relationship test values.
Based on these conclusions, it is recommended to improve access to lifelong education for the elderly to support cognitive health, especially in populations with lower educational backgrounds. Routine screening and management of hypertension and mental health should be prioritized in urban areas, while interventions in rural areas should be tailored to local characteristics. In addition, further research is needed to explore the root causes of hypertension and depression in older adults in both regions to inform more effective and targeted interventions.

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