

Aktivitas Fisik Dan Fungsi Kognitif Pada Calon Jamaah Haji Lanjut Usia *Physical Activity And Cognitive Function In Elderly Prospective Hajj Pilgrims*

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Abstrak

Latar belakang: Jumlah calon jamaah haji lanjut usia Indonesia akan menyebabkan risiko tinggi karena pada kelompok ini gangguan kognitif dapat mempengaruhi keselamatan pelaksanaan ibadah. Aktivitas fisik merupakan faktor protektif yang dapat dimodifikasi, namun bukti pada populasi masih terbatas. **Tujuan:** Penelitian ini dilakukan untuk menilai hubungan aktivitas fisik (*International Physical Activity Questionnaire*, IPAQ) dengan fungsi kognitif (*Montreal Cognitive Assessment* versi Indonesia, MoCA-INA) serta usia dan jenis kelamin sebagai variabel perancu. **Metodologi:** Studi potong lintang dengan data primer pemeriksaan kesehatan calon jamaah haji usia ≥ 50 tahun, 2026. Sebanyak 92 subjek dengan data lengkap dianalisis. MoCA-INA sebagai variabel terikat, IPAQ sebagai variabel bebas, usia dan jenis kelamin sebagai perancu. Uji Kruskal-Wallis, Mann-Whitney, Spearman, regresi linear berganda, dan ANCOVA digunakan; $\alpha = 0,05$. **Hasil dan pembahasan:** Usia rerata $61,07 \pm 7,00$ tahun; skor MoCA-INA rerata $22,34 \pm 3,59$, dengan 72 subjek (78,26%) di bawah 26. Skor MoCA-INA tidak berbeda antar kategori IPAQ ($p = 0,260$). Usia berkorelasi negatif dengan MoCA-INA ($p = -0,248$; $p = 0,017$). Setelah koreksi usia dan jenis kelamin, aktivitas fisik tetap tidak bermakna ($F = 0,768$; $p = 0,467$); hanya usia berhubungan bermakna ($B = -0,113$ /tahun; $p = 0,045$). **Kesimpulan:** Aktivitas fisik tidak berhubungan secara independen dengan fungsi kognitif, demikian pula jenis kelamin. Usia merupakan variabel yang berhubungan paling kuat dengan skor MoCA-INA ($B = -0,113$ /tahun; $p = 0,045$), sehingga skrining kognitif pra-haji perlu memprioritaskan jamaah yang lebih tua.

Kata kunci: fungsi kognitif, aktivitas fisik, jamaah haji lanjut usia

Abstract

Background: Population ageing has increased the number of elderly Indonesian Hajj pilgrims, in whom cognitive impairment may compromise safe Hajj performance. Physical activity is a modifiable protective factor, yet evidence in this population is scarce. **Objective:** This study assessed the association between physical activity (*International Physical Activity Questionnaire*, IPAQ) and cognitive function (*Indonesian Montreal Cognitive Assessment*, MoCA-INA), with age and sex as potential confounders. **Methodology:** A cross-sectional study was conducted using primary data from the pre-departure health examination of prospective pilgrims aged ≥ 50 years in 2026. Ninety-two participants with complete data were analyzed. MoCA-INA score was the dependent variable, IPAQ category was the exposure, age and sex were the covariates. Kruskal-Wallis, Mann-Whitney, Spearman correlation, multiple linear regression and analysis of covariance (ANCOVA) were applied, with $\alpha = 0.05$. **Results:** Participants had a mean age of 61.07 ± 7.00 years and a mean MoCA-INA score of 22.34 ± 3.59 ; 72 participants (78.26%) scored below the cut-off of 26. MoCA-INA scores did not differ significantly across low, moderate and high activity categories ($p = 0.260$). Age correlated negatively with MoCA-INA score ($\rho = -0.248$; $p = 0.017$). After adjustment for age and sex, physical activity remained non-significant ($F = 0.768$; $p = 0.467$) and only age was significantly associated with MoCA-INA score ($B = -0.113$ per year; $p = 0.045$). **Conclusion:** Physical activity was not independently associated with cognitive function, whereas age was the only significant correlate; pre-Hajj cognitive screening should therefore prioritise older pilgrims.

Keywords: cognitive function, physical activity, elderly Hajj pilgrims

1. INTRODUCTION

The Hajj is the fifth pillar of Islam, obligatory for Muslims who are physically, financially and mentally able. Interest in performing the Hajj among the Indonesian population has increased in recent years. Data from the Ministry of Religious Affairs show that the quota allocated to Indonesian pilgrims increased after the COVID-19 pandemic, from 2022 to 2024 [1]. Indonesia is one of the largest number countries sending the pilgrims [2], and in every departure season more than 50% of Indonesian pilgrims are classified as high risk, most of them aged 60 years or older [3]. This combination (a growing quota, a predominantly elderly and high-risk cohort, and a ritual that places substantial physical and cognitive demands on the individual) makes the pre-departure period a critical and increasingly narrow window for identifying pilgrims who may not be able to complete the Hajj safely.

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DOI : 10.35451/jkf.v9i1.4027

Received : 2026-09-30, Accepted: 2026-10-23, Published: 2026-10-30

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The elderly are defined as persons aged 60 years or older, a group that experiences a decline in health status both naturally and as a consequence of other diseases, including a decline in cognitive function that may progress to dementia [4]. Dementia is a chronic or progressive syndrome that impairs memory, thinking, orientation, comprehension, calculation, learning capacity, language and judgement [5]. Its prevalence increases markedly with age: approximately 5% of people older than 65 years and 20–40% of those older than 85 years are affected [6]. The Ministry of Health recorded that the health profile of Indonesian Hajj pilgrims in 2023–2024 was dominated by the elderly, comprising 44% in 2023 and 37% in 2024. Because the 2025 Hajj season carried the theme of “Haji Ramah Lansia” and persons with disabilities, health screening is now performed during the waiting period before departure [7]. This screening is important for detecting risk factors in the elderly, including dementia.

Previous studies have reported several factors associated with dementia in the elderly, namely age, gender, educational level, history of chronic disease, family history of dementia and physical activity. Situmorang (2020) found that age, educational level, health history and physical activity were associated with the occurrence of dementia among the elderly at a primary health center in North Sumatra [8]. Early identification of the signs and symptoms of dementia allows intervention to begin earlier, when the outcome is better than in advanced disease [9]. In the Hajj context this is not a marginal gain. A pilgrim who cannot retain the sequence of rituals, recognize landmarks or follow instructions in a crowded environment is at risk not only of an incomplete Hajj but of physical harm, and the logistical and financial cost of managing such events falls on the pilgrimage organizers and on the wider congregation.

Among these factors, physical activity is particular interest for prospective pilgrims because it is modifiable, whereas age and sex are not. If physical activity were associated with cognitive function in this population, the existing pre-departure examination would already contain a practical, low-cost lever for identifying and counselling at-risk pilgrims. Conversely, if it were not, screening would need to be targeted by non-modifiable factors instead, principally age. Either answer has direct implications for how a national screening programme with limited resources should be organised. Hajj demands sustained physical endurance, and impaired cognitive function may compromise the ability of pilgrims to follow a complex sequence of rituals safely. The pre-departure health examination of prospective pilgrims therefore offers an opportunity for early cognitive screening. This study aimed to analyze the association between physical activity, measured with the International Physical Activity Questionnaire (IPAQ), and cognitive function, measured with the Indonesian version of the Montreal Cognitive Assessment (MoCA-INA), among elderly prospective Hajj pilgrims, and to examine whether age and sex confound this association.

2. METHOD

This was an analytical cross-sectional study using primary data obtained during the pre-departure health examination of prospective Hajj pilgrims. Data were collected during the pre-departure health examination conducted by the Faculty of Medicine, Universitas Islam Indonesia (FK UII), in collaboration with Hajj guidance groups (Kelompok Bimbingan Ibadah Haji, KBIH) in Yogyakarta in 2026. The study population comprised prospective pilgrims in the waiting period for departure who were pre-elderly or elderly. Participants were eligible if they were aged 50 years or older and had complete records of age, sex, IPAQ category and MoCA-INA score. Records of 115 prospective pilgrims were reviewed; 23 records with incomplete data on at least one study variable were excluded, so that 92 participants were analyzed. All participants gave their consent before enrolment, and the study protocol was approved by the Health Research Ethics Committee of FK UII. The dependent variable was cognitive function measured with MoCA-INA (score range 0–30); a score below 26 was classified as cognitive impairment. The independent variable was physical activity measured with the short form of the IPAQ and classified as low, moderate or high. Age (years) and sex were treated as covariates and potential confounders. Cognitive assessment was performed by interview, assisted by family members. Data were analyzed with Python 3.11 (pandas, scipy, statsmodels). Normality was assessed with the Shapiro–Wilk test. Normally distributed variables are presented as mean $\pm$ SD and non-normally distributed variables as median (min–max). MoCA-INA scores across IPAQ categories were compared with the Kruskal–Wallis test as the primary analysis, with one-way ANOVA as a secondary comparison and pairwise Mann–Whitney tests with Bonferroni correction. The association with age was assessed with Spearman correlation and the difference between sexes with the Mann–Whitney U test. Multiple linear regression and analysis of covariance (ANCOVA) with age and sex as covariates

were used to obtain adjusted mean MoCA-INA scores. Residual normality, homoscedasticity, homogeneity of slopes and multicollinearity (variance inflation factor) were examined as model assumptions. A two-sided $p < 0.05$ was considered statistically significant.

3. RESULTS

Ninety-two prospective Hajj pilgrims with complete data were analysed (Table 1). The mean age was 61.07 ± 7.00 years with a median of 61.5 (50–75) years, and most participants were aged 60–69 years (42; 45.65%). Female participants (47; 51.09%) slightly outnumbered male participants (45; 48.91%). Moderate physical activity was the most common IPAQ category (46; 50.00%), followed by high (24; 26.09%) and low activity (22; 23.91%). The median MoCA-INA score was 23.0 (range 14–30) with a mean of 22.34 ± 3.59 , and 72 participants (78.26%) scored below the cut-off of 26.

Table 1. Baseline characteristics of the participants (n = 92).

Characteristic	n	%
Sex		
Male	45	48.91
Female	47	51.09
Age group (years)		
50–59	37	40.22
60–69	42	45.65
70–79	13	14.13
Age, mean $\pm$ SD (median; min–max)	61.07 ± 7.00	61.5; 50–75
IPAQ category		
Low	22	23.91
Moderate	46	50.00
High	24	26.09
MoCA-INA score, mean $\pm$ SD (median; min–max)	22.34 ± 3.59	23.0; 14–30
Cognitive status		
Normal (score $\geq$ 26)	20	21.74
Impaired (score $<$ 26)	72	78.26

Age was not normally distributed (Shapiro–Wilk $p = 0.002$), whereas the MoCA-INA score was acceptable for a normal distribution (Shapiro–Wilk $p = 0.056$); therefore, non-parametric tests were used as the primary analyses. MoCA-INA scores did not differ significantly across physical activity categories (Kruskal–Wallis $H = 2.694$, $df = 2$, $p = 0.260$), and the secondary one-way ANOVA gave the same conclusion ($F = 1.002$; $p = 0.371$). Age correlated negatively and significantly with the MoCA-INA score (Spearman $\rho = -0.248$, $p = 0.017$), whereas the difference in MoCA-INA score between men and women was not statistically significant (Mann–Whitney $U = 825.0$, $p = 0.069$) (Table 2).

Table 2. Bivariate analysis of MoCA-INA score according to physical activity, age and sex (n = 92).

Variable	n	MoCA-INA score, mean $\pm$ SD	Median (min–max)	p
Physical activity (IPAQ)				0.260†
Low	22	22.50 ± 4.17	22.0 (14–30)	
Moderate	46	22.72 ± 3.63	23.0 (14–28)	
High	24	21.46 ± 2.84	21.5 (16–26)	
Age (years)	92	$\rho = -0.248$	61.5 (50–75)	0.017
Sex				0.069‡
Male	45	21.76 ± 3.05	22.0	
Female	47	22.89 ± 3.99	24.0	

†Kruskal–Wallis test; ‡Mann–Whitney U test; Spearman correlation for age. $p < 0.05$ indicates statistical significance.

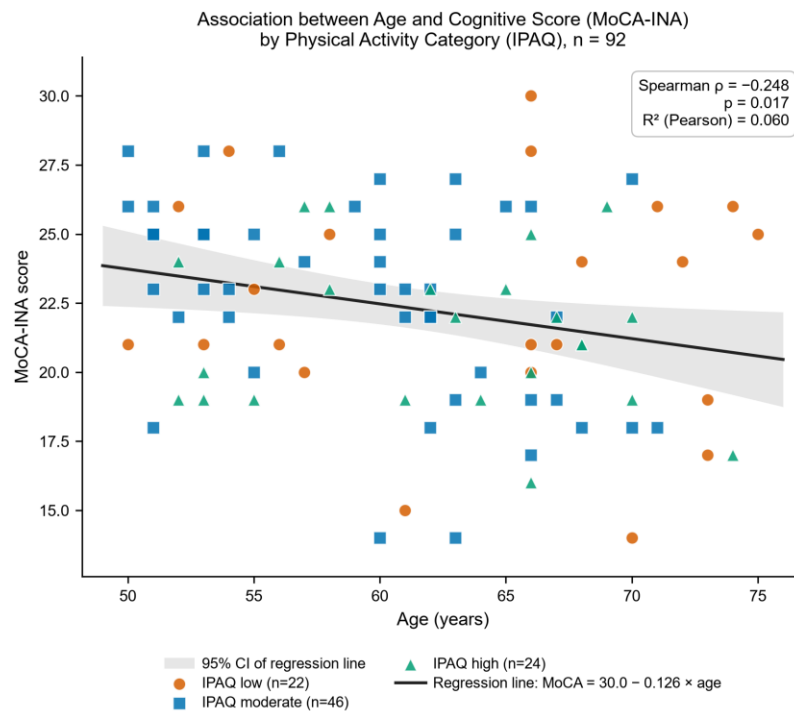


Figure 1. Scatter plot of age against MoCA-INA score by physical activity category. Each point represents one participant ($n = 92$). Colours and marker shapes denote IPAQ category: orange circles = low activity ($n = 22$), blue squares = moderate activity ($n = 46$), green triangles = high activity ($n = 24$). The solid line is the simple linear regression line with its 95% confidence interval. MoCA-INA scores declined with increasing age, while the distributions of the three activity categories overlapped substantially.

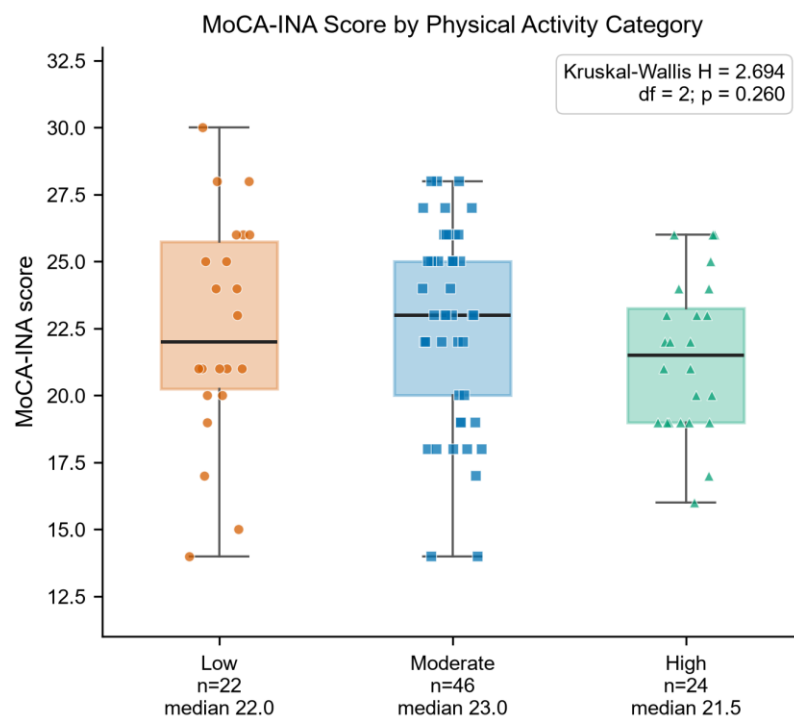


Figure 2. MoCA-INA score by physical activity category. Boxplots show the median, quartiles and interquartile range; individual points represent each participant. Median scores were similar across categories (low 22.0, moderate 23.0, high 21.5) and the difference was not statistically significant ($H = 2.694$, $df = 2$, $p = 0.260$).

In the multiple linear regression model including physical activity category, age and sex, only age was significantly associated with the MoCA-INA score ($B = -0.113$ per year; $p = 0.045$); the effects of moderate and high activity and of sex were not significant ($p = 0.780$, $p = 0.258$ and $p = 0.260$, respectively), and the model explained 9.03% of the variance in the MoCA-INA score (adjusted $R^2 = 4.85\%$, model $p = 0.080$) (Table 3).

Table 3. Multiple linear regression of MoCA-INA score on physical activity, age and sex (n = 92).

Variable	B	SE	95% CI	p
Intercept	30.092	3.578	22.981 to 37.203	< 0.001
Physical activity: moderate vs low	-0.264	0.945	-2.142 to 1.613	0.780
Physical activity: high vs low	-1.180	1.037	-3.242 to 0.882	0.258
Age (per year)	-0.113	0.056	-0.224 to -0.002	0.045
Sex: male vs female	-0.843	0.744	-2.322 to 0.635	0.260
R ² = 9.03%; adjusted R ² = 4.85%; model p = 0.080				

4. DISCUSSION

This study analyzed 92 prospective Hajj pilgrims aged 50 years or older and examined the association between physical activity, assessed with the IPAQ, and cognitive function, assessed with the MoCA-INA. Physical activity was not significantly associated with the MoCA-INA score, both in the crude analysis ($H = 2.694$; $p = 0.260$) and after adjustment for age and sex ($F = 0.768$; $p = 0.467$). This finding is in line with the LIFE randomized trial, in which 24 months of a physical activity intervention did not improve cognitive outcomes compared with health education in sedentary older adults [10]. It differs, however, from a study in a multi-ethnic Asian older adult population that reported significant differences in cognitive function between high, moderate and low activity levels, in which low activity was associated with lower cognitive scores [11].

Several mechanisms support an effect of physical activity on cognition: cells and molecules in the brain are not permanent and can be modified by stimulation that promotes neuronal plasticity [12], [13], and a meta-analysis showed that exercise improves executive function, episodic memory, visuospatial function, verbal fluency and global cognitive function [14]. An observational study likewise reported that elderly people with high physical activity had normal cognitive function [15]. Differences between studies may be explained partly by the instruments used: for example, the AD8 focuses on functional decline and caregiver observation, which may influence the results. Our findings also underline the difficulty of standardizing cognitive screening; the AD8 has nevertheless proved effective and sufficiently sensitive for identifying potential cognitive decline among Hajj pilgrims [16].

Age was the dominant predictor of cognitive function. Median age in this study was 61.5 years (range 50–75), most participants were in the 60–69 year age group, and each additional year of age reduced the MoCA-INA score by 0.113 points ($p = 0.045$). This is consistent with a study among Hajj pilgrims that reported a high prevalence of probable cognitive impairment (64%) in older adults aged 60 years or older [16], a prevalence exceeding worldwide figures reported for this age band. That difference may be influenced by the assessment method, as previous studies used the Mini-Cog test [17], [18]. Another study found that advanced age, lower educational level and the need for assistance during Hajj were significant predictors of cognitive impairment in univariate analysis, although only low education and the need for assistance remained significant in multivariate analysis [19]; these findings are supported by a systematic review that concluded that age and level of education are major risk factors for dementia [20].

Cognitive decline is a natural process with increasing age. The risk may be increased by physical inactivity, family history, low educational level, head injury, exposure to toxins, and chronic diseases such as diabetes, heart disease, stroke and Parkinson disease [21]. This decline can nevertheless be slowed by preventive measures, and for the elderly regular physical activity is one of the most effective strategies for preserving cognitive function [22]. Stimulation through physical activity may slow cognitive decline in the elderly [23]. Specifically, exercise stimulates the brain to increase production of brain-derived neurotrophic factor (BDNF), a key protein that maintains the health of nerve cells, whereas reduced BDNF concentrations may trigger dementia [24].

Sex was not significantly associated with the MoCA-INA score after adjustment for age and physical activity ($p = 0.260$), and the fully adjusted model explained only 9.03% of the total variance in cognitive score. Reported sex differences in dementia risk are inconsistent. One study found a more rapid decline among women in global cognitive and executive measures, while verbal memory was spared a pattern attributed to sex specific cognitive reserve [25]; another study reported a higher prevalence among women explained by biological factors such as

hormones, health-related factors such as cardiovascular risk, and social factors such as level of education. The reason for the slower cognitive decline among women in the Framingham Offspring Study remains uncertain and has been attributed to socioeconomic factors, stress levels, geographical and environmental conditions, and cohort differences in sampling strategy, eligibility criteria and cognitive tests [25]. Decline in verbal memory in women tends to become apparent only at a more advanced neurodegenerative stage than in men, presumably because of higher baseline verbal memory scores and greater cognitive reserve [26]. Bivariate differences in cognitive function between sexes in the elderly are generally not statistically significant and are strongly influenced by age and sociodemographic conditions [27], while other studies have emphasized differences in educational attainment among women and biological variation such as atherosclerosis and hormonal profiles [28], [29], and observed that cognitive performance remained better in women despite lower education [30].

The aspect of our analysis deserve emphasis. The association between the IPAQ category and the MoCA-INA score was not significant even before adjustment, which may reflect the nature of the IPAQ, which captures only broad categories of habitual activity in daily life rather than the type, intensity and duration of exercise, as well as the homogeneity of activity levels and unmeasured confounders in this population. These findings are nevertheless relevant to clinical practice: 78.26% of participants screened below the cognitive cut-off, which supports pre-Hajj cognitive screening of at-risk elderly pilgrims, worship counselling and involvement of caregivers so that the Hajj is performed safely and in accordance with Islamic law. This study enriches the literature on cognitive screening in the elderly and provides a basis for further research.

5. CONCLUSION

Age was the only variable significantly associated with cognitive function in elderly prospective Hajj pilgrims: each additional year of age reduced the MoCA-INA score by 0.113 points ($p = 0.045$), and 78.26% of participants scored below the cut-off of 26. Sex was not significantly associated with cognitive function, indicating that the risk of cognitive decline did not differ substantially between men and women in this population. Physical activity measured with the IPAQ was not significantly associated with cognitive function, either before ($p = 0.260$) or after adjustment for age and sex ($p = 0.467$), and the fully adjusted model explained only 9.03% of the variance in the MoCA-INA score.

This study has several limitations. Other confounders such as educational level, comorbidity and depressive symptoms did not control yet. Physical activity was self-reported and categorized broadly, which is subject to recall bias. Future studies should use objective measures of physical activity such as accelerometers, longitudinal designs and different cognitive assessment instruments to monitor cognitive trajectories in elderly Hajj pilgrims more precisely.

6. ACKNOWLEDGMENT

The authors thank the Faculty of Medicine, Universitas Islam Indonesia, and the collaborating Hajj guidance groups (KBIH) for their support during data collection, and all prospective pilgrims who participated in the health examination. This study received no external funding, and the authors declare no conflict of interest.

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