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Prevalence and Associated Factors of Mild Cognitive Impairment in Parkinson's Disease: A Single-Center Study in Thailand

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ABSTRACT

Objectives: Mild cognitive impairment (MCI) is a frequent non-motor complication and a strong predictor of dementia in patients with Parkinson's disease (PD). Reported prevalence rates vary considerably due to differences in diagnostic criteria and study populations, with limited data available from Thai cohorts. This study aimed to determine the prevalence of PD-MCI and identify associated factors among Thai patients with PD.

Materials and Methods: A cross-sectional study was conducted involving 100 patients with mild to moderate PD who attended the Movement Disorders Clinic at Vajira Hospital, Bangkok, between February and October 2023. Patients with disabilities, dementia, or major neurological comorbidities were excluded. Cognitive function was assessed using the Thai version of the Montreal Cognitive Assessment in patients with PD who reported cognitive concerns, as reported by patients, caregivers, or both, applying a cutoff score of < 25 points and adding one point for participants with ≤ 6 years of education. Demographic, clinical, and comorbidity data were collected. Independent predictors of PD-MCI were analyzed using univariate and multivariate logistic regression models.

Results: Among 100 patients with PD, 54% were female. Nearly one-third of participants (31%) had completed education beyond grade 12, and the median disease duration was 3 years. The prevalence of PD-MCI was 81%. Patients with PD-MCI were significantly older (74.3 ± 8.3 vs. 66.5 ± 8.7 years, $p < 0.001$), had lower educational attainment (45.7% vs. 10.5% below grade 6, $p = 0.005$), and lower body mass index (BMI) (23.2 ± 4.1 vs. 25.5 ± 4.2 kg/m², $p = 0.035$). Hypertension, hyperlipidemia, later age at onset, and mixed phenotype were also associated in univariate analyses. In multivariate regression, age ≥ 70 years (adjusted odds ratio (OR), 6.77; 95% confidence interval (CI), 1.35-34.08), education below grade 6 (adjusted OR, 10.35; 95% CI, 1.68-63.88), and obesity (BMI ≥ 25 kg/m²; adjusted OR, 0.07; 95% CI, 0.01-0.55) remained independent predictors.

Conclusion: PD-MCI is highly prevalent among Thai patients with PD. Older age, low education level, and lower BMI independently increased risk, whereas obesity appeared protective. Routine cognitive screening and targeted interventions are essential for this population. Further longitudinal studies are warranted to explore causal mechanisms.

Keywords: cognitive screening, mild cognitive impairment, Parkinson's disease

INTRODUCTION

Parkinson's disease (PD) is the second most common neurodegenerative disorder globally. It is characterized not only by classic motor symptoms such as bradykinesia, rigidity and tremor, but also by various non-motor complications such as neuropsychiatric disturbances, autonomic dysfunction, constipation, sleep problems, and cognitive decline, all of which significantly impair quality of life.[1] Mild cognitive impairment (MCI) in patients with PD (PD-MCI) has gained increasing recognition as a key non-motor manifestation and a major risk factor for subsequent PD dementia (PDD).[2,3] Longitudinal studies indicate that several individuals with PD-MCI eventually progress to PDD, whereas other remain cognitively stable or revert to normal cognition, highlighting its heterogeneous clinical course.[4] Early identification of PD-MCI is therefore essential to facilitate preventive strategies, timely counseling, and cognitive rehabilitation, which may collectively help delay functional decline.[5]

Previous research has shown wide variability in the prevalence of PD-MCI, ranging from 20% to 70%. This variation is largely explained by differences in study design, diagnostic criteria, cognitive assessment tools, and population characteristics.[6-12] Several clinical and demographic factors have been associated with PD-MCI, including advanced age, male sex, lower educational attainment, longer disease duration, greater disease severity, and vascular comorbidities such as hypertension and diabetes mellitus.[8,9,13]

Thailand, now an aging society, faces a rising prevalence of PD, particularly in urban areas with a tertiary hospital where differences in education level, healthcare accessibility, and vascular risk profiles may affect the risk of cognitive decline.[14] Despite this trend, limited data exist regarding PD-MCI among Thai populations. This study therefore aimed to determine the prevalence of PD-MCI and to identify its associated factors among patients with PD attending a tertiary hospital in Thailand.

MATERIALS AND METHODS

This cross-sectional study was conducted at the Movement Disorders Clinic, Vajira Hospital, Navamindradhiraj University, between February and October 2023. Ethical approval was obtained from the Institutional Review Board of Vajira Hospital (COA number 092/2566). The sample size was calculated using the single population proportion formula, with a significance level of 0.05, a margin of error of 0.10, and an expected prevalence of PD-MCI of 23.3% based on a previous study.[15] The minimum required sample size was 69 participants. After adjusting for an anticipated 30% rate of incomplete data, the final target sample size was set at 100 participants. Consecutive patients with a clinical diagnosis of PD according to the United Kingdom Parkinson's Disease Society Brain Bank diagnostic criteria by movement disorders specialists were invited to participate.

Eligible patients were aged ≥ 40 years, had mild to moderate disease defined by Hoehn and Yahr (H&Y) stages 1-4, and had no prior diagnosis of dementia. Exclusion criteria included severe disability (H&Y stage 5), impairment in activities of daily living due to cognitive decline, or comorbid neurological disorders such as stroke, dementia and intellectual disability.

The primary outcome was the prevalence of PD-MCI among patients with PD in a Thai cohort. The secondary outcome was the identification of clinical and demographic factors associated with PD-MCI. Data collected included demographic characteristics (sex, age, educational level, and body mass index (BMI)), PD-related features (disease duration, motor phenotype, lateralization, H&Y stage, and levodopa equivalent daily dose), and comorbidities (hypertension, diabetes mellitus, and hyperlipidemia).

PD-MCI was identified using a screening-based definition consistent with the Movement Disorder Society Task Force Level I criteria, which require the presence of subjective cognitive complaints together with objective cognitive impairment detected by a validated cognitive screening tool.[7] All patients underwent cognitive screening reported cognitive concerns, as noted by the patients themselves, caregivers, or both, during routine clinic visits. Cognitive function was evaluated using the Thai version of the Montreal Cognitive Assessment (Thai-MoCA), applying a cutoff score of < 25 points for MCI diagnosis. An additional point was added for participants with ≤ 6 years of education, following the Thai Clinical Practice Guideline for Dementia.[16] The assessment was administered by trained neurology residents during the same outpatient visit and required approximately 15 minutes to complete. Patients were instructed to take their PD medications as prescribed before cognitive testing to ensure assessment during their "on" state.

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Data analyses were performed using IBM SPSS Statistics version 29.0. Between-group comparisons (PD-MCI vs non-MCI) were conducted using the Chi-square or Fisher's exact test for categorical variables and the independent t-test or Mann-Whitney U test for continuous variables, as appropriate. Univariate analyses were followed by multivariate logistic regression to identify independent predictors of PD-MCI. Odds ratio (OR) with 95% confidence interval (CI) were reported, and a p-value < 0.05 was considered statistically significant.

RESULTS

A total of 100 patients with PD were enrolled. The mean age was 72.82 ± 8.90 years, most participants (43%) aged between 65 and 74 years. Females comprised 54% of the cohort. Regarding education, 31% had completed studies beyond grade 12.

The mean BMI was 23.65 ± 4.19 kg/m², with 47% falling within the normal BMI range (18.5-22.9 kg/m²). Comorbidities were highly prevalent, as 88% of patients had at least one chronic condition. Hypertension was the most common (61%), followed by hyperlipidemia (52%) and diabetes mellitus (29%). Smoking and alcohol consumption were reported by 14% and 9% of patients, respectively. The mean hemoglobin A1c (HbA1c) was 6.13 ± 0.81, and 27.1% had HbA1c levels > 6.5%. Other biochemical parameters were generally within normal limits.

The mean age at PD onset was 68.06 ± 9.63 years, and the median disease duration was 3 years (interquartile range (IQR) 1.5-6.5). Most patients (71%) had a disease duration of ≤ 5 years. The majority were classified as H&Y stage 1 (62%). Regarding motor phenotype, the tremor-dominant subtype was most common (36%), followed by the mixed phenotype (30%), and the remainder were akinetic-rigid. Family history of PD was reported in 7% of participants. The median levodopa equivalent daily dose was 372.5 mg (IQR 200-757), with 51% receiving < 400 mg daily **(Table 1)**.

The prevalence of PD-MCI was 81% **(Table 2)**. The mean Thai-MoCA total score was 19.0 ± 5.1, with an education-adjusted mean of 19.4 ± 4.9. Domain analysis revealed mean scores as follows: visuospatial 2.36 ± 1.64, naming 2.80 ± 0.57, attention 4.42 ± 1.40, language 1.43 ± 0.98, abstraction 1.10 ± 0.75, and delayed recall 1.37 ± 1.46. Orientation was relatively preserved (5.54 ± 1.06).

Table 1 Demographic and Clinical Characteristics of Patients with Parkinson's Disease

Characteristics	Total (n = 100)
Age (years), mean ± SD	72.82 ± 8.9
Min-Max	(48-91)
< 65	14 (14.0)
65-74	43 (43.0)
75-84	36 (36.0)
> 85	7 (7.0)
Gender	
Female	54 (54.0)
Education level	
Below grade 4	22 (22.0)
Grade 4-6	17 (17.0)
Grade 7-9	10 (10.0)
Grade 10-12	20 (20.0)
Above grade 12	31 (31.0)

Table 1 Demographic and Clinical Characteristics of Patients with Parkinson's Disease (cont.)

Characteristics	Total (n = 100)
Body mass index (kg/m^2), mean ± SD	23.65 ± 4.19
Min-Max	(14.95-42.68)
Normal (18.5-22.9)	47 (47.0)
Overweight (23.0-24.9)	23 (23.0)
Obesity (≥ 25)	30 (30.0)
Comorbidity	88 (88.0)
Hypertension	61 (61.0)
Diabetes mellitus	29 (29.0)
Dyslipidemia	52 (52.0)
Coronary artery disease	9 (9.0)
Atrial fibrillation	5 (5.0)
Chronic kidney disease	13 (13.0)
Chronic obstructive pulmonary disease	4 (4.0)
Thyroid disease	4 (4.0)
Fatty liver	2 (2.0)
Others[a]	22 (22.0)
Smoking[b]	14 (14.0)
Alcohol[b]	9 (9.0)
HbA1c, (n = 59) mean ± SD	6.13 ± 0.81
≥ 6.5	16 (27.1)
Total cholesterol (mg/dL), (n = 91) mean ± SD	170.38 ± 43.56
> 200	17 (18.7)
Triglyceride (mg/dL), (n = 93) mean ± SD	110.90 ± 52.00
> 150	19 (20.4)
HDL-cholesterol (mg/dL), (n = 91) mean ± SD	55.13 ± 16.37
LDL-cholesterol (mg/dL), (n = 93) mean ± SD	106.12 ± 38.75
> 100	2 (2.2)
Creatinine (mg/dL), (n = 97) mean ± SD	0.97 ± 0.26
eGFR (mL/min/1.73m^2), (n = 97) mean ± SD	70.43 ± 17.56
> 90	12 (12.4)
60-89	56 (57.7)
30-59	29 (29.9)
Onset age (years), mean ± SD	68.06 ± 9.63

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Table 1 Demographic and Clinical Characteristics of Patients with Parkinson's Disease (cont.)

Characteristics	Total (n = 100)
Duration (years), median (IQR)	3 (1.5-6.5)
≤ 5	71 (71.0)
> 5	29 (29.0)
H&Y stage	
1	62 (62.0)
2	20 (20.0)
3	10 (10.0)
4	8 (8.0)
Phenotype	
Tremor	36 (36.0)
Akinetic rigid	33 (33.0)
Mixed	31 (31.0)
Lateralization	
Right	55 (55.0)
Left	45 (45.0)
Family history	7 (7.0)
Levodopaequivalent dose (mg)	372.5 (200 - 757)
< 400	51 (51.0)
400-599	13 (13.0)
≥ 600	36 (36.0)

Abbreviations: dL, deciliter; eGFR, estimated glomerular filtration rate; H&Y, Hoehn and Yahr; HbA1c, hemoglobin A1c; HDL, high-density lipoprotein; IQR, interquartile range; kg, kilogram; LDL, low-density lipoprotein; m^2, square meter; Max, maximum; mg, milligram; Min, minimum; min, minute; mL, milliliter; n, number; SD, standard deviation

Data are presented as number (%), mean ± standard deviation or median (interquartile range).

[a] Others include gastroesophageal reflux disease, benign prostatic hyperplasia, rheumatoid arthritis, asthma, nonalcoholic steatohepatitis, gout and knee osteoarthritis.

[b] Smoking and alcohol consumption refer to current use at the time of assessment.

Comparative analyses revealed several factors associated with PD-MCI **(Table 3)**. Patients with PD-MCI were significantly older than those without MCI (74.31 ± 8.31 vs. 66.47 ± 8.74 years; p < 0.001). A higher proportion of patients with PD-MCI were aged ≥ 70 years (75.3% vs. 31.6%; p < 0.001).

Education attainment was a strong determinant, as nearly half of patients with PD-MCI (45.7%) had not completed grade 6, compared with only 10.5% among those with normal cognition (p = 0.005). BMI demonstrated an inverse relationship with cognitive impairment. The mean BMI was lower in the MCI group than in the normal cognition group (23.22 ± 4.10 vs. 25.47 ± 4.21 kg/m²; p = 0.035). Normal BMI (18.5-22.9 kg/m²) was more common in the PD-MCI group (53.1%), whereas overweight status (BMI ≥ 25 kg/m²) was more common among those without MCI (52.6%, p = 0.024).

Comorbidities also showed significant differences. Hypertension was more prevalent in the PD-MCI group (69.1% vs. 26.3%; p = 0.001), as was hyperlipidemia (56.8% vs. 31.6%; p = 0.048).

Table 2 Thai-MoCA Scores and Cognitive Impairments among Patients with Parkinson's Disease

Variables	Total (n = 100)		
	Mean ± SD	Min	Max
Visuospatial (0-5)	2.36 ± 1.64	0	5
Naming (0-3)	2.80 ± 0.57	0	3
Attention (0-6)	4.42 ± 1.40	1	6
Language (0-3)	1.43 ± 0.98	0	3
Abstraction (0-2)	1.10 ± 0.75	0	2
Delayed recall (0-5)	1.37 ± 1.46	0	5
Orientation (0-6)	5.54 ± 1.06	0	6
Total score (0-30)	19.02 ± 5.12	3	28
Total score (education-adjusted)	19.41 ± 4.91	4	28
Memory index score (0-15)	7.55 ± 4.44	0	15
< 7 - n (%)	38 (38.0)		
≥ 7 - n (%)	62 (62.0)		
Cognitive impairments			
Mild cognitive impairment - n (%)	81 (81.0)		
Normal - n (%)	19 (19.0)		

Abbreviation: n, number

Patients with PD-MCI had a later mean age at PD onset (69.79 ± 8.64 vs. 60.68 ± 10.37 years, $p < 0.001$). Regarding motor subtype, mixed phenotype was more common among PD-MCI patients (37.0%), while the tremor-dominant subtype predominated in those with normal cognition (52.6%, $p = 0.025$).

Univariate logistic regression confirmed these associations **(Table 4)**. Age ≥ 70 years was significantly associated with PD-MCI (OR, 6.61; 95% CI, 2.22-19.68; $p = 0.001$), as was education below grade 6 (OR, 7.15; 95% CI, 1.55-32.98; $p = 0.012$). Obesity (BMI ≥ 25 kg/m²) was inversely associated with PD-MCI (OR, 0.19; 95% CI, 0.05-0.67; $p = 0.010$). Hypertension was a significant factor (OR, 6.27; 95% CI, 2.04–19.31; $p = 0.001$). Furthermore, later age at PD onset (OR, 1.11; 95% CI, 1.04-1.18; $p = 0.001$) and mixed phenotype (OR, 11.54; 95% CI, 1.38-96.29; $p = 0.024$) increased PD-MCI risk.

In the multivariate logistic regression model, after adjustment for confounding variables, three independent predictors remained: age ≥ 70 years (adjusted OR, 6.77; 95% CI, 1.35-34.08; $p = 0.020$), education below grade 6 (adjusted OR, 10.35; 95% CI, 1.68-63.88; $p = 0.012$), and obesity BMI ≥ 25 kg/m², which was protective (adjusted OR, 0.07; 95% CI, 0.01-0.55; $p = 0.012$). Although hypertension and later PD onset were significant in univariate analysis, they did not remain independent predictors in the multivariate model, likely due to collinearity with age and education.

DISCUSSION

In this Thai cohort of patients with PD, we found a strikingly high prevalence of PD-MCI, affecting 81% of participants. This rate exceeds the range reported in most international studies (20%-70%), which may be attributed to differences in diagnostic approaches, study populations, and sociocultural factors. In Thailand, many older adults live in extended families where relatives often compensate for their functional deficits,

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Table 3 Factors Associated with PD-MCI

Variables	MCI (n = 81)	Normal (n = 19)	P-value
Age (years), mean ± SD	74.31 ± 8.31	66.47 ± 8.74	< 0.001[t]
Min-Max	(49-91)	(48-81)	
< 70	20 (24.7)	13 (68.4)	< 0.001[c]
≥ 70	61 (75.3)	6 (31.6)	
Gender			
Female	43 (53.1)	11 (57.9)	0.705[c]
Education level			
> Grade 6	44 (54.3)	17 (89.5)	0.005[c]
< Grade 6	37 (45.7)	2 (10.5)	
Body mass index (kg/m^2), mean ± SD	23.22 ± 4.10	25.47 ± 4.21	0.035[t]
Min-Max	(14.95-42.68)	(19.72-36.79)	
Normal (18.5-22.9)	43 (53.1)	4 (21.1)	0.024[c]
Overweight (23.0-24.9)	18 (22.2)	5 (26.3)	
Obesity (≥ 25)	20 (24.7)	10 (52.6)	
Comorbidity	73 (90.1)	15 (78.9)	0.234[f]
Hypertension	56 (69.1)	5 (26.3)	0.001[c]
Diabetes mellitus	22 (27.2)	7 (36.8)	0.403[c]
Dyslipidemia	46 (56.8)	6 (31.6)	0.048[c]
Coronary artery disease	8 (9.9)	1 (5.3)	1.000[f]
Atrial fibrillation	5 (6.2)	0 (0.0)	0.580[f]
Chronic kidney disease	12 (14.8)	1 (5.3)	0.452[f]
Chronic obstructive pulmonary disease	4 (4.9)	0 (0.0)	1.000[f]
Thyroid disease	4 (4.9)	0 (0.0)	1.000[f]
Fatty liver	2 (2.5)	0 (0.0)	1.000[f]
Others[a]	18 (22.2)	4 (21.1)	1.000[f]
Smoking[b]	13 (16.0)	1 (5.3)	0.296[f]
Alcohol[b]	9 (11.1)	0 (0.0)	0.201[f]
HbA1c, (n = 59) mean ± SD	6.06 ± 0.79	6.37 ± 0.88	0.225[t]
≥ 6.5	11 (23.9)	5 (38.5)	
Total cholesterol (mg/dL), (n = 91) mean ± SD	168.86 ± 42.74	176.56 ± 47.53	0.505[t]
> 200	11 (15.1)	6 (33.3)	0.094[f]
Triglyceride (mg/dL), (n = 93) mean ± SD	108.37 ± 49.70	121.44 ± 61.13	0.341[t]
> 150	16 (21.3)	3 (16.7)	1.000[f]
HDL-cholesterol (mg/dL), (n = 91) mean ± SD	54.51 ± 16.41	57.67 ± 16.40	0.466[t]

Table 3 Factors Associated with PD-MCI (cont.)

Variables	MCI (n = 81)	Normal (n = 19)	P-value
LDL-cholesterol (mg/dL), (n = 93) mean ± SD	106.67 ± 39.77	103.83 ± 35.10	0.782[t]
> 100	2 (2.7)	0 (0.0)	1.000[f]
Creatinine (mg/dL), (n = 97) mean ± SD	0.98 ± 0.28	0.94 ± 0.20	0.625[t]
eGFR (mL/min/1.73m^2), (n = 97) mean ± SD	69.12 ± 17.78	76.19 ± 15.78	0.124[t]
> 90	9 (11.4)	3 (16.7)	0.667[c]
60-89	45 (57.0)	11 (61.1)	
30-59	25 (31.6)	4 (22.2)	
Onset age (years), mean ± SD	69.79 ± 8.64	60.68 ± 10.37	< 0.001[t]
Duration (years), median (IQR)	3 (1-6.5)	4 (2-8)	0.307[m]
≤ 5	57 (70.4)	14 (73.7)	0.774[c]
> 5	24 (29.6)	5 (26.3)	
H&Y stage			
1-2	64 (79.0)	18 (94.7)	0.183[f]
3-4	17 (21.0)	1 (5.3)	
Phenotype			
Tremor	26 (32.1)	10 (52.6)	0.025[c]
Akinetic rigid	25 (30.9)	8 (42.1)	
Mixed	30 (37.0)	1 (5.3)	
Lateralization			
Right	47 (58.0)	8 (42.1)	0.209[c]
Left	34 (42.0)	11 (57.9)	
Family history	6 (7.4)	1 (5.3)	1.000[f]
Levodopa equivalent dose (mg)	440 (200 - 790)	250 (150 - 575)	0.302[m]
< 400	39 (48.1)	12 (63.2)	0.320[c]
400-599	10 (12.3)	3 (15.8)	
≥ 600	32 (39.5)	4 (21.1)	

Abbreviations: dL, deciliter; eGFR, estimated glomerular filtration rate; H&Y, Hoehn and Yahr; HbA1c, hemoglobin A1c; HDL, high-density lipoprotein; IQR, interquartile range; kg, kilogram; LDL, low-density lipoprotein; m^2, square meter; Max, maximum; MCI, mild cognitive impairment; mg, milligram; Min, minimum; min, minute; mL, milliliter; n, number; PD, Parkinson's disease; SD, standard deviation

Data are presented as number (%), mean ± standard deviation or median (interquartile range).

P-value corresponds to [t]Independent samples t-test, [m]Mann-Whitney U test, [c]Chi-square test or [f]Fisher's exact test.

[a] Others include gastroesophageal reflux disease, benign prostatic hyperplasia, rheumatoid arthritis, asthma, nonalcoholic steatohepatitis, gout and knee osteoarthritis.

[b] Smoking and alcohol consumption refer to current use at the time of assessment.

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potentially masking early signs of cognitive impairment. Furthermore, since this study was conducted in a specialized Movement Disorders Clinic, it likely included patients with more complex disease profiles or treatment-refractory disease and a higher burden of non-motor symptoms, including cognitive complaints. Since all patients included in this study presented with subjective cognitive concerns that prompted screening. The advanced age of the sample may have further contributed to the high prevalence observed.

Consistent with prior research, older age and lower educational attainment emerged as strong independent predictors of PD-MCI. Age is a well-established risk factor reflecting both disease-related and age-associated neurodegeneration. Meanwhile, lower educational attainment—an indicator of reduced cognitive reserve—has been repeatedly linked to increased vulnerability to cognitive impairment in PD and the general population.[17] These findings highlight the need for targeted screening among older and

Table 4 Univariable and Multivariable Analysis using Multiple Logistic Regression Analysis of Associated Factors of PD-MCI in Parkinson's Disease

Factors	Univariable Analysis			Multivariable Analysis		
	OR[a]	95% CI	P-value	OR_{adj}[b]	95% CI	P-value
Age (years)						
< 70	1.00	Reference		1.00	Reference	
≥ 70	6.61	(2.22-19.68)	0.001	6.77	(1.35-34.08)	0.020
Gender						
Female	1.00	Reference				
Male	1.22	(0.44-3.34)	0.705			
Education level						
> Grade 6	1.00	Reference		1.00	Reference	
< Grade 6	7.15	(1.55-32.98)	0.012	10.35	(1.68-63.88)	0.012
BMI (kg/m^2)						
Normal (18.5-22.9)	1.00	Reference		1.00	Reference	
Overweight (23.0-24.9)	0.34	(0.08-1.39)	0.132	0.12	(0.01-1.24)	0.075
Obesity (≥ 25)	0.19	(0.05-0.67)	0.010	0.07	(0.01-0.55)	0.012
Comorbidity	2.43	(0.65-9.13)	0.188			
Hypertension	6.27	(2.04-19.31)	0.001	4.49	(0.80-25.15)	0.088
Diabetes mellitus	0.64	(0.22-1.83)	0.405			
Dyslipidemia	2.85	(0.98-8.24)	0.054	1.63	(0.32-8.24)	0.556
Coronary artery disease	1.97	(0.23-16.8)	0.534			
Atrial fibrillation	-	-	NA			
Chronic kidney disease	3.13	(0.38-25.69)	0.288			
Chronic obstructive pulmonary disease	-	-	NA			
Thyroid disease	-	-	NA			
Fatty liver	-	-	NA			
Others	1.07	(0.32-3.63)	0.912			

Table 4 Univariable and Multivariable Analysis using Multiple Logistic Regression Analysis of Associated Factors of PD-MCI in Parkinson's Disease (cont.)

Factors	Univariable Analysis			Multivariable Analysis		
	OR[a]	95% CI	P-value	OR_{adj} [b]	95% CI	P-value
Smoking	3.44	(0.42-28.08)	0.249			
Alcohol	-	-	NA			
HbA1c, (n = 59)						
< 6.5	1.00	Reference				
> 6.5	0.50	(0.14-1.86)	0.302			
Total cholesterol > 200 mg/dL	0.36	(0.11-1.15)	0.083			
Triglyceride > 150 mg/dL	1.36	(0.35-5.27)	0.660			
LDL-cholesterol > 100 mg/dL	-	-	NA			
Onset age (years)	1.11	(1.04-1.18)	0.001			
Duration (years)						
≤ 5	1.00	Reference				
> 5	1.18	(0.38-3.64)	0.775			
H&Y stage						
1-2	1.00	Reference				
3-4	4.78	(0.6-38.41)	0.141	0.64	(0.05-8.63)	0.735
Phenotype						
Tremor	1.00	Reference		1.00	Reference	
Akinetic rigid	1.20	(0.41-3.54)	0.738	0.93	(0.16-5.48)	0.932
Mixed	11.54	(1.38-96.29)	0.024	14.92	(0.91-245.13)	0.058
Lateralization						
Right	1.90	(0.69-5.23)	0.214			
Left	1.00	Reference				
Family history	1.44	(0.16-12.72)	0.743			
Levodopa equivalent dose (mg)						
< 400	1.00	Reference		1.00	Reference	
400-599	1.03	(0.24-4.34)	0.973	4.12	(0.37-45.78)	0.249
≥ 600	2.46	(0.72-8.37)	0.149	2.64	(0.44-15.90)	0.290

Abbreviations: BMI, body mass index; CI, confidence interval; dL, deciliter; H&Y, Hoehn and Yahr; HbA1c, hemoglobin A1c; kg, kilogram; LDL, low-density lipoprotein; m^2, square meter; MCI, mild cognitive impairment; mg, milligram; n, number; NA, not applicable; OR, odds ratio; ORadj, adjusted odds ratio; PD, Parkinson's disease

Variable was included in multivariable model due to have p-value < 0.200 in univariable analysis.

[a] Crude odds ratio estimated by binary logistic regression.

[b] Adjusted odds ratio estimated by multiple logistic regression.

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less-educated patients with PD, particularly in developing countries such as Thailand, where educational attainment varies widely across generations and regions.[18]

Interestingly, obesity (BMI ≥ 25 kg/m²) was inversely associated with PD-MCI. This finding supports previous observations in PD and other neurodegenerative conditions, where higher BMI has sometimes been linked to a lower risk of cognitive decline.[19] This phenomenon, known as the "obesity paradox," refers to the counterintuitive observation that overweight or mildly obese older adults may experience better functional outcomes than those with normal or low BMI.[20] Possible mechanisms include greater nutritional status and metabolic reserve, which may protect against neurodegenerative processes, whereas low BMI may indicate frailty—a condition strongly associated with poor cognitive outcomes and increased dementia risk.[21]

Weight loss is common as PD progresses, and lower BMI may reflect disease advancement and greater neurodegenerative burden.[22] However, BMI alone does not differentiate fat from lean mass. Evidence suggests that muscle mass and strength (sarcopenia) are more closely related to cognition than fat mass.[23] These findings suggest that body composition, rather than BMI alone, may play a critical role in PD-related cognitive outcomes. Future research should incorporate measures of muscle mass, fat distribution, and frailty indices to clarify the underlying biological mechanisms.

Although hypertension, hyperlipidemia, and later age at disease onset were significantly associated with MCI in univariate analyses, they did not remain significant in the multivariate model, likely due to collinearity with age and education. Nevertheless, vascular comorbidities remain biologically plausible contributors to cognitive decline in PD, as cerebral small-vessel disease and white matter changes have been linked to impaired cognition.[24] In this cohort, brain imaging was not routinely performed; therefore, subclinical cerebrovascular pathology may have contributed to cognitive impairment in some patients, particularly those with vascular risk factors. However, vascular comorbidities were not independent predictors of PD-MCI after multivariable adjustment, suggesting that age and education were the primary contributors in this cohort. Future studies using neuroimaging to assess vascular burden in Thai patients with PD could further elucidate these associations.

The findings of this study have several clinical implications. First, the high prevalence of PD-MCI in Thai populations underscores the importance of incorporating cognitive screening into routine PD management, particularly for patients aged ≥ 70 years or with limited education. The MoCA, which is sensitive to executive and visuospatial deficits, is practical for outpatient use and allows early detection of cognitive decline. Preventive measures such as cognitive training, patient education, and aggressive management of vascular risk factors should be prioritized in this high-risk group.

This study has several limitations. First, the relatively small sample size (n = 100), recruitment from a single tertiary center in Bangkok and all participants were presented with cognitive concerns which may limit generalizability, particularly to rural populations where educational and health access profiles differ. Second, the use of a single cognitive screening tool (MoCA) without comprehensive neuropsychological testing based on the Movement Disorder Society Level II criteria limits diagnostic precision. Third, brain imaging was not systematically obtained, which limits the ability to exclude subclinical cerebrovascular disease or other structural brain abnormalities as contributors to cognitive impairment. Finally, the absence of a non-PD control group restricts comparison and external validation of the identified risk factors.

CONCLUSION

This study revealed a notably high prevalence of MCI among patients with PD in a Thai population, affecting more than 80% of participants. Older age, lower educational attainment, and lower BMI were identified as independent predictors of PD-MCI. Although vascular comorbidities such as hypertension and hyperlipidemia were associated with PD-MCI in univariate analyses, they did not remain independent predictors after adjustment. These findings emphasize the need for routine cognitive screening in PD care, particularly for elderly and less-educated patients, to facilitate early detection and timely management of cognitive decline. Considering Thailand's rapidly aging population and increasing prevalence of PD, integrating cognitive assessment into standard clinical care is crucial. Future longitudinal, multicenter studies and incorporating direct measures of body composition are recommended to elucidate causal mechanisms and inform prevention

and management strategies for cognitive impairment in PD.

Conflict of Interest

The authors have no financial interest related to the topic of this manuscript.

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Formal analysis: S.S., T.B.

Funding acquisition: -

Investigation: S.S.

Methodology: S.S., T.B.

Project administration: S.S.

Resources: T.B.

Software: T.B.

Supervision: T.B.

Validation: T.B.

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Writing – review & editing: T.B.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to restrictions.

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