

# Timing of Rehabilitation Therapy Initiation and All-Cause Mortality in Parkinson's Disease : A Nationwide Cohort Study

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## INTRODUCTION

- Rehabilitation is recommended as an integral component of comprehensive Parkinson's disease (PD) management from the early stages, yet remains underutilized in clinical practice globally.
- Moreover, evidence on its long-term impact on survival remains limited.
- This study evaluated the association between rehabilitation initiation timing after PD diagnosis and all-cause mortality, and whether this association differed by disability severity at rehabilitation initiation, using a large-scale nationwide cohort from South Korea.

## MATERIALS & METHODS

- Using data from the Korean National Health Insurance Service (NHIS)
- We identified 19,153 individuals newly diagnosed with PD between 2006 and 2023 who received rehabilitative developmental therapy for central nervous system disorders.
- Participants were stratified by time from PD diagnosis to rehabilitation initiation (<1 year, 1–2 years, ≥2 years) and by disability severity at rehabilitation initiation (no disability, mild-to-moderate, severe), classified using the National Disability Registration system.
- Cox proportional hazards regression models estimated adjusted hazard ratios (HRs) for all-cause mortality, with follow-up through December 31, 2023.
- Subgroup analyses further examined the association between rehabilitation timing and mortality stratified by disability severity.

## RESULTS

- Table 1 summarizes the baseline demographic and clinical characteristics of the participants.
- Compared with patients initiating rehabilitation within 1 year of diagnosis, those beginning therapy at 1–2 years demonstrated a 22% higher mortality risk (HR 1.22, 95% CI 1.16–1.29), and those with delays of ≥2 years showed a 25% higher risk (HR 1.25, 95% CI 1.20–1.30) (Table 2).
- Disability severity at rehabilitation initiation was also associated with mortality, with risks increasing progressively from 18% for mild to 40% for severe disability.
- In stratified analysis, earlier rehabilitation was consistently associated with reduced mortality across all disability subgroups, with a dose-response trend toward increasing risk with longer delays (all p for trend <0.05). No significant interaction was observed between rehabilitation timing and mortality across disability severity (p for interaction = 0.491).

**Table 1. Demographic and Clinical Characteristics According to the Time from Parkinson's Disease Diagnosis to Rehabilitation Therapy Initiation**

Characteristics	Time from PD diagnosis to rehabilitation initiation			p-value
	<1 year	1–2 year	≥2 year	
N	6,170	2,590	10,393	
Age, mean (SD)	75.00 (8.86)	73.84 (9.07)	75.60 (8.61)	<0.001
Sex				0.010
Men	2,650 (42.9)	1,203 (46.4)	4,603 (44.3)	
Women	3,520 (57.1)	1,387 (53.6)	5,790 (55.7)	
Income levels				0.007
Q1 (lowest)	1,109 (18.0)	427 (16.5)	1,948 (18.7)	
Q2	735 (11.9)	294 (11.4)	1,185 (11.4)	
Q3	1,265 (20.5)	508 (19.6)	1,938 (18.6)	
Q4 (highest)	3,061 (49.6)	1,361 (52.5)	5,322 (51.2)	
Residential area				<0.001
Rural	3,646 (59.1)	1,445 (55.8)	5,814 (55.9)	
Urban	2,524 (40.9)	1,145 (44.2)	4,579 (44.1)	
Insurance type				0.006
Medical aid	255 (4.1)	105 (4.1)	529 (5.1)	
National health insurance	5,915 (95.9)	2,485 (95.9)	9,864 (94.9)	
Charlson comorbidity index				<0.001
0	100 (1.6)	102 (3.9)	395 (3.8)	
1	333 (5.4)	215 (8.3)	871 (8.4)	
2	549 (8.9)	326 (12.6)	1,218 (11.7)	
≥3	5,188 (84.1)	1,947 (75.2)	7,909 (76.1)	
Other comorbidities*				
Hypertension	4,635 (75.1)	1,809 (69.8)	7,128 (68.6)	<0.001
Dyslipidemia	4,637 (75.2)	1,800 (69.5)	7,298 (70.2)	<0.001
Pneumonia	1,117 (18.1)	459 (17.7)	2,057 (19.8)	0.006
Urinary tract infection	1,746 (28.3)	685 (26.4)	2,697 (26.0)	0.004
Hip fracture	255 (4.1)	121 (4.7)	465 (4.5)	0.441
Depression	3,289 (53.3)	1,231 (47.5)	4,986 (48.0)	<0.001
Current smoker	430 (7.0)	159 (6.1)	468 (4.5)	<0.001
Heavy drinker	891 (14.4)	389 (15.0)	1,461 (14.1)	0.430
Physically active individuals	1,215 (19.7)	654 (25.3)	2,739 (26.4)	<0.001
Body mass index (kg/m <sup>2</sup> )	23.96 ± 3.35	24.02 ± 3.25	24.04 ± 3.37	0.302

Continuous variables are presented as mean (SD) and categorical variables as n (%).  
\*Non-Charlson Comorbidity Index comorbidities.

**Table 2. Cox Proportional Hazard Regression Analysis on the Association between Initiation Timing of Rehabilitation Therapy and All-Cause Mortality in Individuals with Parkinson's Disease**

Time from PD diagnosis to rehabilitation initiation	PD (n)	Mortality (n)	Person years	Mortality rate	Model 1	p-value	Model 2	p-value	Model 3	p-value
<1 year	6,170	4,170	26,997.33	154.46	reference		reference		reference	
1-2 years	2,590	1,769	10,224.94	173.01	1.13 (1.07-1.20)	<0.001	1.17 (1.11-1.24)	<0.001	1.22 (1.16-1.29)	<0.001
≥2 years	10,393	5,400	31,299.06	172.53	1.15 (1.11-1.20)	<0.001	1.15 (1.11-1.20)	<0.001	1.25 (1.20-1.30)	<0.001

Mortality rate is the incidence of mortality per 1000 person-years

Model 1: unadjusted

Model 2: adjusted for age, sex, income level, insurance type, and residential area

Model 3: adjusted for age, sex, income level, insurance type, residential area, comorbidities, lifestyle factors, body mass index, and levodopa equivalent daily dose

PD indicates Parkinson's disease

## DISCUSSION

- Delayed rehabilitation initiation and greater disability at rehabilitation onset were each independently associated with increased all-cause mortality, with earlier rehabilitation conferring survival advantages across all disability severity categories.
- These findings highlight the need for systematic incorporation of rehabilitation referral into standard clinical workflows at the time of PD diagnosis.

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