Clinical Epidemiology

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RESEARCH LETTER

Validation of Parkinson's Disease Diagnoses in a National Register: Accuracy, Limitations, and Utility

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Purpose: To evaluate the diagnostic validity of PD identification in a national health registry requiring neurologist-confirmed diagnoses.

Patients and Methods: We analyzed the Turku PD Cohort including 1626 patients diagnosed with PD between 2006 and 2020 in specialist care. Patients were identified based on ≥2 entries of ICD-10 code G20. Diagnoses were re-evaluated through detailed chart review after a median follow-up of approximately 10 years. Two movement disorder specialists independently classified final diagnoses based on clinical records, imaging, and treatment data. Linkage to the Finnish Register of the Entitlements to Reimbursement of Pharmaceutical Expenses identified patients granted reimbursement for antiparkinsonian medications under ICD-10 code G20. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated using the final clinical diagnosis as the reference.

Results: Of the 1626 patients, 1550 (95.3%) had received reimbursement for PD medications. After long-term follow-up, 1314 were confirmed as PD and 236 reclassified to alternative diagnoses. Registry identification showed high sensitivity (98.2%) and PPV (84.8%). Only 24 confirmed PD cases (1.8%) were not captured. Diagnostic revisions most commonly reflected atypical or secondary parkinsonian syndromes. Specificity was lower (18.1%), reflecting diagnostic evolution during follow-up rather than systematic miscoding. The median delay between diagnosis and registry entry was 24 days.

Conclusion: A national health registry requiring neurologist-confirmed diagnoses enables highly sensitive PD case identification with good PPV for epidemiological research. However, diagnostic evolution in early parkinsonism limits specificity in cross-sectional register data. Registry studies should therefore apply follow-up exclusion algorithms for alternative parkinsonian diagnoses.

Keywords: Parkinson's disease, epidemiology, validation, registry, reimbursement, diagnosis

Introduction

Accurate Parkinson's disease (PD) case identification is essential for robust epidemiological and clinical research. As large-scale observational studies increasingly rely on routinely collected health data to investigate disease incidence, prevalence, risk factors, and treatment outcomes, the diagnostic validity of PD in such health registries is critically important.[1] Registries offer broad coverage and follow-up, but their utility depends on diagnostic code accuracy, which may lack specialist confirmation or follow-up validation. Methodological frameworks for registry research emphasize the need for validation studies comparing registry-based diagnoses with clinical reference standards and reporting measures such as sensitivity, specificity, and predictive values.[2]

Numerous validation studies have shown wide variation in the accuracy of register-based PD case identification. Reported positive predictive values (PPVs) range from 46.5% in U.S. administrative health registries to over 85% in European cohorts using repeated codes, prescriptions, or specialist input.[3,4] However, few studies have assessed both the ability to correctly identify true PD cases (sensitivity) and to exclude non-PD cases (specificity); or systematically examined how healthcare system design and reimbursement protocols influence diagnostic accuracy.

https://doi.org/10.2147/CLEP.S564684
Received: 15 September 2025
Accepted: 20 April 2026
Published: 20 May 2026

Several healthcare systems, including those in the United Kingdom, Germany, Canada, and France, promote specialist involvement in the diagnostic process of PD or include administrative validation steps that may enhance the accuracy of register-based research. In Finland, antiparkinsonian drug reimbursement specifically for PD requires a neurologist-confirmed diagnosis and a detailed written statement submitted to the Social Insurance Institution. This process offers a distinct framework for register-based case identification. Although the Finnish Register of the Entitlements to Reimbursement of Pharmaceutical Expenses is frequently used in PD epidemiology (eg.[5–7]), its diagnostic accuracy has not previously been validated against long-term specialist-confirmed clinical diagnoses. To our knowledge, no prior study has systematically evaluated both sensitivity and specificity within this reimbursement framework.

Accordingly, the objective of this study was to evaluate the diagnostic accuracy of PD entries in this national health registry. Using long-term clinical follow-up as a reference, we calculated sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), and considered the implications of these findings for future research on PD relying on administrative healthcare data.

Materials and Methods

Study Population

We examined data from the Turku PD Cohort, comprising 1626 patients diagnosed with PD between 2006 and 2020 at Turku University Hospital and affiliated outpatient clinics. All patients were diagnosed by a neurologist or supervised resident, following national guidelines. The cohort has been described previously.[8]

Patients were identified from EHRs based on ≥2 entries of ICD-10 code G20. The study design followed a diagnostic validation framework, using long-term specialist-confirmed clinical diagnoses as the reference standard. Cases with uncertain coding or baseline alternative diagnoses were excluded. Full clinical records, including notes, imaging, and medications, were independently reviewed by two movement disorder specialists (V.K. and T.K.) using standardized criteria over a median follow-up period of 10 years. Each case was classified as confirmed PD or revised (eg., atypical parkinsonism, DLB, vascular or drug-induced parkinsonism).

Registry Linkage and Case Definition

Registry data on special reimbursement for antiparkinsonian drugs (Register of the Entitlements to Reimbursement of Pharmaceutical Expenses) were obtained from the Finnish Social Insurance Institution (Kela). The reimbursement code 110 covers antiparkinsonian medications and may be granted for multiple parkinsonian syndromes. For this study, we included only patients for whom reimbursement code 110 was approved specifically for ICD-10 code G20 (PD). Registry data were linked using personal identification numbers. The final clinical diagnosis after 10 years served as the reference standard.

Diagnostic Accuracy and Validity of Registry

For measuring the validity of the registry we calculated sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) using clinically confirmed diagnoses as the reference. We also assessed the proportion of confirmed PD cases not captured in the registry and calculated the time lag between clinical diagnosis and register entry.

Statistical Analysis

Analyses were conducted using IBM SPSS Statistics, version 30.0 (IBM Corp., Armonk, NY). Diagnostic accuracy measures were calculated with exact 95% confidence intervals using the Clopper-Pearson method. Group comparisons were performed using chi-square tests for categorical variables. Time delays were summarized with medians and interquartile ranges. Continuous variables were summarized with means (standard deviations) or medians (interquartile ranges) and categorical variables with frequencies (percentages). A two-sided p-value <0.05 was considered statistically significant.

Results

Of the 1,626 PD patients in the clinical cohort, 1,550 (95.3%) had received drug reimbursement for PD medications. Among these, 1,314 (84.8%) had a confirmed PD diagnosis upon patient record review, while 236 (15.2%) were later reclassified (Table 1). Diagnostic validity measures are presented in Table 2. We also calculated validity using a broader definition including DLB and monogenic PD. Drug reimbursement was more frequent among patients with a confirmed PD diagnosis (1314 of 1338; 98.2%) compared to those whose diagnoses were revised to an alternative condition (236 of 288; 81.9%) ($p<0.001$).

Additionally, 24 (1.8%) confirmed PD patients were not found in the Register of the Entitlements to Reimbursement of Pharmaceutical Expenses. The mean age of these patients at PD diagnosis was 76.7 (SD 12.2) years, and 14 were male. During the follow-up period, 11 of these patients had died, with a median interval of 34 months (IQR 34) between diagnosis and death. In 9 cases, a neurologist had documented preparation of a drug reimbursement statement, but these patients were nevertheless not recorded in the register. Two patients had reported choosing not to submit the statement to Kela, and one patient died shortly after the statement was issued.

Table 1 Summary of Final Diagnoses and Proportions of Patients in the Drug Reimbursement Register for Each Diagnostic Category

Final Diagnosis	n	Age at PD Diagnosis Mean (SD, Range)	Sex % Males	Categorized as PD in Reimbursement Register % (n)
PD	1338	68.5 (11.2, 30–95)	55.5	98.2 (1314)
Clinically undetermined parkinsonian syndrome	77	67.8 (10.4, 30–92)	57.1	85.7 (66)
Dementia with Lewy bodies	69	74.3 (7.5, 57–90)	59.4	89.9 (62)
Vascular parkinsonism	30	73.2 (9.3, 54–88)	63.3	76.7 (23)
PSP-RS	29	71.8 (7.6, 54–85)	65.5	82.8 (24)
MSA-P	24	65.2 (11.2, 46–79)	45.8	87.5 (21)
Essential tremor	15	73.4 (8.4, 56–87)	53.3	60.0 (9)
Drug-induced parkinsonism	12	73.5 (7.4, 59–85)	41.7	50.0 (6)
CBS	6	71.1 (4.9, 63–76)	50.0	100 (6)
Alzheimer's disease	4	78.3 (4.8, 74–83)	75.0	75.0 (3)
Monogenic PD	4	37.8 (8.1, 26–43)	25.0	100 (4)
Normal pressure hydrocephalus	4	77.4 (5.3, 70–82)	50.0	0 (0)
Depression	3	69.3 (19.2, 48–84)	33.3	66.7 (2)
PSP-CBS	2	73.0 (3.0, 71–75)	100	100 (2)
Functional neurological disorder	2	50.5 (3.0, 48–53)	50.0	100 (2)
Motor neuron disease	2	60.8 (3.4, 58–63)	100	100 (2)
Other[A]	5	65.7 (11.3, 55–78)	100	80.0 (4)
Total	1626	69.0 (11.1, 26–95)	55.9	95.3 (1550)

Notes: [A]Dystonia (n=1), AD combined with DLB (n=1), hepatic encephalopathy (n=1), unspecified myalgia (n=1) and unspecified tauopathy (n=1).
Abbreviations: PSP-*RS*, Progressive supranuclear palsy – Richardson syndrome; MSA-P, Multiple system atrophy – parkinsonian subtype; CBS, Corticobasal syndrome; PSP-CBS, Progressive supranuclear palsy – corticobasal syndrome.

https://doi.org/10.2147/CLEP.S564684

Table 2 Diagnostic Accuracy and Registry Validity of the Drug Reimbursement Register in Identifying PD, with and without Inclusion of Dementia with Lewy Bodies (DLB) and Monogenic Parkinsonism

	Confirmed PD Excluding DLB and Monogenic PD	**Confirmed PD Including DLB and Monogenic PD**
n	1314	1380
PPV (%)	84.8 (82.9–86.5)	89.0 (87.4–90.5)
NPV (%)	68.4 (56.7–78.6)	59.2 (47.3–70.4)
Sensitivity (%)	98.2 (97.3–98.8)	97.8 (96.9–98.5)
Specificity (%)	18.1 (13.8–23.0)	20.9 (15.7–27.0)

Notes: Diagnostic accuracy metrics (positive predictive value [PPV], negative predictive value [NPV], sensitivity, and specificity) are shown for registry-identified PD cases using clinically confirmed diagnoses as the reference standard. Estimates are presented both when DLB and monogenic parkinsonism are excluded (left column) and included (right column) in the definition of confirmed PD. Values are expressed as percentages with 95% confidence intervals in parentheses.

Discussion

This study evaluated the diagnostic performance of PD identification in a specialist-certified national reimbursement registry. Using long-term clinical record reviews as the reference standard, we found that a register requiring neurologist-confirmed diagnoses achieved high sensitivity (98.2%) and positive predictive value (PPV; 84.8%) in identifying true PD cases. Only 1.8% of clinically verified cases were missed, and the median delay between clinical diagnosis and register entry was 24 days. These results support the utility of structured specialist-based systems, where reimbursement eligibility requires neurologist confirmed diagnoses and standardized documentation, for registry-based research. The findings also suggest refinement through exclusion algorithms accounting for diagnostic evolution.

Compared to previous register validation efforts, our findings are notably strong. In a large U.S. Veterans Administration study, Goldman et al reported a PPV of only 46.5% using primary diagnosis codes alone, rising to 85% when enriched algorithms incorporating neurologist visits and treatment response were applied.[3] A systematic review across multiple health systems found wide heterogeneity in PD case ascertainment methods, ranging from simple diagnostic codes to more complex definitions involving prescriptions, hospital episodes, or death records.[4] While several included studies achieved PPVs >80%, sensitivity was often unreported, and specificity rarely addressed. Our study adds to this literature by evaluating both sensitivity and specificity in a specialist-diagnosed cohort with long-term follow-up, using detailed patient records as a clinical reference.

Our findings also illustrate the practical trade-offs inherent in real-world validation studies. The "bottom-up" design used here, beginning with clinically diagnosed PD patients and assessing their representation in the register, enabled accurate measurement of sensitivity and identification of register-missed cases. In contrast, most prior studies have used "top-down" designs that sample register-defined PD cases and validate diagnoses through medical records. While such approaches provide direct estimates of PPV, they cannot evaluate sensitivity or identify register-missed cases. Our bottom-up design, beginning with clinically confirmed PD patients, enables assessment of sensitivity and under-ascertainment but limits estimation of specificity at the population level.

However, our approach has limitations. This cohort was derived from a single defined geographical region in Finland. Although the reimbursement process is nationally standardized, regional variation in diagnostic practices may still occur. Therefore, external validation in other Finnish regions and in countries with comparable reimbursement frameworks is warranted. Moreover, since the cohort comprised clinically diagnosed PD patients, specificity could only be estimated within this subgroup. This is a common limitation in register validation studies, which often assess defined subsets rather

than full register populations due to practical constraints. The observed low specificity (18.1%) reflects diagnostic change over time, many patients initially considered to have PD were ultimately reclassified with atypical parkinsonism or other conditions. This diagnostic evolution illustrates the challenge of using cross-sectional registry data for progressive conditions. Our findings echo the need to supplement registry data with follow-up exclusions for diagnoses.

We also identified 24 patients (1.8%) with clinically confirmed PD who were not present in the reimbursement registry. In some cases, the reimbursement application process may have been interrupted (eg., patients declined to apply or died before processing). For others, no clear explanation was available, raising the possibility of system-level lapses. Although these findings indicate that even highly structured, specialist-based administrative systems may fail to capture all eligible patients, the small number of missing cases suggests that the extent of under-ascertainment is limited.

Our findings support certain strategies to improve PD case identification in administrative data. First, structured diagnostic requirements, such as specialist confirmation and fulfilment of PD clinical diagnostic criteria, can significantly improve registry sensitivity and PPV. Second, exclusion algorithms based on subsequent codes for atypical or secondary parkinsonism should be routinely applied to enhance specificity. In our cohort, most diagnostic revisions occurred within the first two years after the initial PD diagnosis, with common alternative diagnoses including MSA, PSP, vascular parkinsonism, and clinically undetermined parkinsonism (CUPS).[8] These findings support the application of at least a two-year diagnostic window when implementing such exclusions in registry-based case definitions. Third, multi-source linkage (eg., with hospital records) should be considered where feasible, particularly in systems without mandatory specialist involvement. Finally, even in healthcare systems that appear well-structured, it is essential to validate registry data locally.

Conclusion

In sum, this study highlights the strengths of neurologist-certified administrative registries in PD research and offers strategies for improving case definitions. While no system is free from diagnostic uncertainty or omissions, targeted methodological refinements, such as incorporating exclusion algorithms and leveraging specialist-confirmed diagnoses, can meaningfully enhance diagnostic accuracy.

Statement of Ethics

The study was conducted using retrospectively collected clinical data and national health registry data. According to Finnish legislation (Act on the Secondary Use of Health and Social Data 552/2019) governing register-based research, ethics committee approval was not required because the study involved no patient contact, interventions, or collection of new biological material. Permission to use the clinical data was granted by the Wellbeing Services County of Southwest Finland (Varha) and national registry linkage was approved by Findata (THL/1965/14.02.00/2024). All of the included patient data used in the study were handled in accordance with applicable data protection and privacy regulations. Access to the data was restricted to authorized investigators only.

Disclosure

Professor Anna-Maija Tolppanen reports grants paid to institution from Horizon EU, Michael J Fox Foundation for Parkinson's research, EMA framework contracts, Amgen, Sanofi, outside the submitted work. Professor Valtteri Kaasinen reports Valtion Tutkimusrahoitus) (VTR) funds from Turku University Hospital, during the conduct of the study; and grants paid to the institution from the Finnish Parkinson Foundation, the Päivikki and Sakari Sohlberg Foundation, and the Turku University Foundation, outside the submitted work. He also reports Speaker's honoraria from Abbvie, Nordic Infucare and Lundbeck, and advisory board memberships for Abbvie, Nordic Infucare and Orion Pharma. The authors report no other conflicts of interest in this work.

References

1. Ben-Shlomo Y, Darweesh S, Llibre-Guerra J, Marras C, San Luciano M, Tanner C. The epidemiology of Parkinson's disease. *Lancet*. 2024;403 (10423):283–292. doi:10.1016/S0140-6736(23)01419-8
2. Sørensen ST, Kristensen FP, Troelsen FS, Schmidt M, Sørensen HT. Health registries as research tools: a review of methodological key issues. *Dan Med J*. 2023;70(4).

3. Goldman SM, Weaver FM, Cao L, et al. Validation of Parkinson's Disease ascertainment in the veterans administration electronic medical record. *Mov Disord*. 2025;40(2):245–253. doi:10.1002/mds.30075
4. Harding Z, Wilkinson T, Stevenson A, et al. Identifying Parkinson's disease and parkinsonism cases using routinely collected healthcare data: a systematic review. *PLoS One*. 2019;14(1):e0198736. doi:10.1371/journal.pone.0198736
5. Isotalo J, Vahlberg T, Kaasinen V. Unchanged long-term rural-to-urban incidence ratio of Parkinson's disease. *Mov Disord*. 2017;32(3):474–475. doi:10.1002/mds.26862
6. Paakinaho A, Koponen M, Tiihonen M, Kauppi M, Hartikainen S, Tolppanen AM. Disease-Modifying antirheumatic drugs and risk of parkinson disease: nested case-control study of people with rheumatoid arthritis. *Neurology*. 2022;98(12):e1273–e81. doi:10.1212/WNL.0000000000013303
7. Havulinna AS, Tienari PJ, Marttila RJ, et al. Geographical variation of medicated parkinsonism in Finland during 1995 to 2000. *Mov Disord*. 2008;23(7):1024–1031. doi:10.1002/mds.22024
8. Räty V, Kuusimäki T, Majuri J, et al. Stability and accuracy of a diagnosis of parkinson disease over 10 years. *Neurology*. 2025;104(9):e213499. doi:10.1212/WNL.0000000000213499