A Scientometric Analysis of Bias and Fairness in Parkinson's Disease Clinical Assessment Scales

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Title Page

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Abstract

Background: Clinical assessment scales are fundamental tools for evaluating Parkinson disease, yet potential biases in their development and validation may compromise their fairness across diverse populations **Objectives:** To conduct a comprehensive scientometric analysis examining demographic representation, geographic distribution, and methodological biases in Parkinson disease assessment scale literature. **Methods:** Following PRISMA guidelines, we systematically searched five databases from inception to 2024. Studies validating or developing Unified Parkinson Disease Rating Scale, Movement Disorder Society-Unified Parkinson Disease Rating Scale, Montreal Cognitive Assessment, or Mini-Mental State Examination for Parkinson disease were included. Data extraction focused on 17 predefined bias domains including demographic representation and methodological considerations. **Results:** From 3,836 studies, 109 met inclusion criteria, encompassing 655 authors across 34 countries. High-income countries contributed 99 publications (90.8%) versus 10 publications (9.2%) from low/middle-income countries. Critical gaps included: 8 studies (7.3%) captured race/ethnicity data, 13 studies (11.9%) adjusted cognitive tests for education, and zero studies addressed digital literacy barriers. Female authorship was 36.6% overall. **Conclusions:** This analysis reveals persistent geographic, demographic, and methodological biases in Parkinson disease assessment research, potentially compromising fairness across diverse populations. These findings highlight urgent needs for inclusive research practices and culturally sensitive scale adaptations.

Keywords: Parkinson disease; clinical assessment; bias; fairness; scientometric analysis; demographic disparities; health equity

Introduction

Parkinson disease affects over 10 million people worldwide, with prevalence projected to reach 25.2 million by 2050. Clinical assessment scales serve as fundamental tools for diagnosis, monitoring disease progression, and evaluating treatment efficacy. The most widely used scales include the Unified Parkinson Disease Rating Scale and its revised Movement Disorder Society version for motor symptoms, and cognitive assessments such as the Montreal Cognitive Assessment and Mini-Mental State Examination.

Recent studies have highlighted concerning disparities in clinical research, with underrepresentation of diverse populations potentially limiting the generalizability and fairness of medical interventions. In neurodegenerative diseases, assessment tools developed primarily in high-income, predominantly white populations may not perform equally across different demographic groups. These biases can manifest as geographic concentration of research in wealthy nations, underrepresentation of women and minorities, inadequate consideration of cultural factors, and methodological gaps in addressing confounding variables.

Despite the critical importance of fair assessment tools, no comprehensive analysis has examined the extent of bias and demographic representation in the foundational literature supporting Parkinson disease clinical assessment scales. This knowledge gap represents a significant barrier to understanding potential biases and developing targeted interventions to address them.

Methods

Study Design

We conducted a comprehensive scientometric analysis following established guidelines for bibliometric research, employing a systematic two-phase approach combining quantitative bibliometric analysis with qualitative assessment of methodological biases.

Search Strategy and Selection Criteria

A systematic literature search was conducted across five major databases (PubMed, Embase, Medline and Central) from inception to July 31, 2024. The search strategy was developed using the following terms: ("Parkinson*" OR "PD") AND ("UPDRS" OR "MDS-UPDRS" OR "Unified Parkinson Disease Rating Scale" OR "MoCA" OR "Montreal Cognitive Assessment" OR "MMSE" OR "Mini Mental State") AND ("valid*" OR "develop*" OR "assess*" OR "scale" OR "instrument").

Inclusion criteria: (1) Studies validating or developing Parkinson disease assessment scales; (2) English articles; (3) Peer-reviewed publications; (4) Human subjects with Parkinson disease.

Exclusion criteria: (1) Case reports and editorials; (2) Non-English publications; (3) Studies not focusing on Parkinson disease assessment scales; (4) Animal studies; (5) Conference abstracts without full text.

Data Extraction and Bias Assessment Framework

Data extraction was performed independently by two reviewers using a standardized form. **Seventeen predefined bias domains** were assessed based on established frameworks for demographic bias in clinical research, categorized into primary demographic domains (race/ethnicity, sex/gender, age-specific values, educational background, geographic representation, socioeconomic status, administrator training, digital literacy barriers) and methodological domains (assessment timing,

treatment controls, medication state documentation, cognitive domain specification, institutional resources, subgroup analysis, inclusion criteria, confounding variables, sample size adequacy).

Statistical Analysis

Descriptive statistics were calculated for all variables. Chi-square tests assessed associations between categorical variables. Geographic disparities were analyzed using Global North-South classification and World Bank income categories. Statistical significance was set at $p < 0.05$. All analyses were performed using Python 3.12.

Data Sharing

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request. All data extraction forms and analysis scripts used in this study will be made publicly available upon publication.

Results

Study Selection and Characteristics

The systematic search yielded 3,836 potentially relevant studies. After duplicate removal and screening, 141 full-text articles were assessed for eligibility, with 109 studies ultimately meeting inclusion criteria for analysis **(Figure 1).** The included studies encompassed 655 authors across 34 countries and were published in 47 different journals between 1996 and 2024.

Publication Trends and Geographic Distribution

Publication trajectories revealed distinct temporal patterns reflecting clinical adoption and research maturity. The Unified Parkinson Disease

Rating Scale demonstrated consistent usage throughout the analyzed period, with peak activity during 2010-2019 coinciding with the Movement Disorder Society revision. The Montreal Cognitive Assessment showed rapid adoption between 2008-2016, reaching maximum publication volume during 2014-2015, followed by recent decline. The Mini-Mental State Examination maintained steady but moderate levels with mid-period surge during 2014-2020 (**Figure 2**).

Geographic analysis revealed significant disparities

Geographic analysis **(Figure 3)** revealed significant disparities in research distribution. High-income countries contributed 99 publications (90.8%), while low/middle-income countries contributed only 10 publications (9.2%). Europe dominated with 48 publications (44.0%), followed by North America with 39 publications (35.8%).

Asia showed pronounced disparities between high-income (9 publications, 8.3%) and low/middle-income contributions (4 publications, 3.7%). Africa and South America, despite having significant Parkinson disease populations, contributed minimally with 2 (1.8%) and 3 (2.8%) publications respectively.

Authorship Patterns and Gender Distribution

Among 655 total authors, 240 (36.6%) were female and 415 (63.4%) were male. Gender representation varied by authorship position: first authorship showed 25 female authors (32.9%) compared to 51 male authors (67.1%), while senior authorship demonstrated 26 female authors (37.1%) versus 44 male authors (62.9%).

Bias Domain Assessment

Comprehensive analysis of 109 studies revealed significant variations in bias domain consideration **(Table 1).**

Cognitive impairment criteria specification was most frequently addressed (49 studies, 45.0%), followed by sex/gender analysis (47 studies, 43.1%) and cognitive domain specification (43 studies, 39.4%).

Critical gaps were identified in several domains **(Figure 4)**. Digital literacy and access barriers were not addressed in any study (0.0%). Treatment effects on cognition were considered in only 1 study (0.9%), and age-specific normative values in merely 3 studies (2.8%). Race and ethnicity data collection was documented in only 8 studies (7.3%), while medication state testing occurred in 4 studies (3.7%) for OFF state and 18 studies (16.5%) for ON state.

Education adjustment for cognitive tests was performed in only 13 studies (11.9%), institutional resources reporting in 11 studies (10.1%), and confounding variables control in 16 studies (14.7%). The mean percentage of studies addressing any given bias domain was 17.8%, with a median of 14.7%.

Journal and Citation Analysis

Studies were published across 47 journals. Specialized movement disorders journals accounted for 45 publications (41.3%): Movement Disorders (n=29), Parkinsonism & Related Disorders (n=11), and Movement Disorders Clinical Practice (n=5). Impact factor quartile analysis revealed 24 studies (19.8%) in Q1 journals, 35 studies (32.1%) in Q2 journals, 38 studies (34.9%) in Q3 journals, and 12 studies (11.0%) in Q4 journals.

Discussion

Principal Findings

This scientometric analysis provides compelling evidence of significant and persistent biases in PD clinical assessment scale research. The

predominance of research from high-income countries, male authorship patterns, and critical gaps in methodological consideration of bias factors collectively threaten the global applicability and fairness of current assessment instruments.

Geographic and Economic Disparities

The stark geographic concentration of research in high-income countries (90.8% of publications) represents a fundamental threat to the global validity of Parkinson disease assessment scales.

This disparity is particularly concerning given epidemiological projections showing fastest growth in Parkinson disease prevalence in low- and middle-income countries. The near-absence of research from Africa (1.8% of publications) and limited representation from South America (2.8%) creates significant knowledge gaps about scale performance in these populations.

These geographic biases have direct clinical implications. Assessment scales developed and validated primarily in Western, educated, industrialized, rich, and democratic populations may not adequately capture the disease experience in other cultural contexts. Factors such as cultural attitudes toward neurological symptoms, linguistic nuances in symptom description, and healthcare system differences can all influence scale performance and interpretation.

Demographic Representation Gaps

The underrepresentation of critical demographic factors represents a significant methodological weakness. Only 7.3% of studies captured race/ethnicity data, despite well-documented disparities in Parkinson disease presentation and progression across racial groups. This gap is particularly problematic given evidence that cognitive assessment tools demonstrate differential performance across racial and ethnic groups.

The finding that only 11.9% of studies adjusted cognitive assessments for educational background is especially concerning. Educational attainment significantly influences performance on cognitive tests, and failure to account for this factor can lead to systematic biases in diagnosis and severity assessment, potentially contributing to disparities in Parkinson disease dementia diagnosis and treatment access.

Methodological Bias Implications

The identified methodological gaps have direct implications for clinical practice and research validity. The absence of studies addressing digital literacy barriers (0.0% of publications) is particularly concerning in an era of increasing digital health implementation. As Parkinson disease assessment increasingly incorporates technology-based tools, failure to consider digital access and literacy creates new forms of bias that may exacerbate existing health disparities.

Inadequate reporting of administrator training (present in only 30.3% of studies) raises questions about inter-rater reliability and consistency across different clinical settings. This gap is particularly problematic for global implementation of assessment scales, where training resources and expertise may vary significantly.

Implications and Future Directions

These findings have immediate implications for clinical practice and health policy. Clinicians must recognize that current Parkinson disease assessment scales may not perform equally across all patient populations. This recognition should inform clinical decision-making, particularly when evaluating patients from underrepresented demographic groups.

Our findings point to several critical research priorities: (1) Inclusive validation studies specifically designed to assess scale performance across diverse demographic groups; (2) Systematic investigation of

cultural and linguistic factors affecting scale performance for global implementation; (3) Research addressing digital literacy and access barriers as assessment tools increasingly incorporate digital components; (4) Development and testing of specific interventions to reduce bias in clinical assessment.

Limitations

This study has limitations including restriction to English-language publications, potentially underrepresenting research from non-English speaking countries. The retrospective nature limits assessment of causality between identified biases and clinical outcomes. Publication bias may have influenced findings, as studies with negative results regarding bias may be less likely published. Additionally, assessment of bias domains relied on information reported in published manuscripts, which may not fully capture all considerations addressed during study conduct.

In conclusion, this comprehensive scientometric analysis reveals pervasive and systematic biases in the foundational literature supporting Parkinson disease clinical assessment scales. The stark geographic concentration of research in high-income countries, persistent gender disparities in research leadership, and critical gaps in demographic and methodological bias consideration collectively threaten the fairness and global applicability of current assessment instruments. These findings have immediate implications for clinical practice, requiring heightened awareness of potential biases when using Parkinson disease assessment scales across diverse populations. The research community must prioritize inclusive research practices, cross-cultural validation studies, and development of bias-aware assessment tools. Only through systematic efforts can we ensure that fundamental tools used to evaluate Parkinson disease provide fair and accurate assessments across all

affected populations, regardless of geography, demographics, or socioeconomic status.

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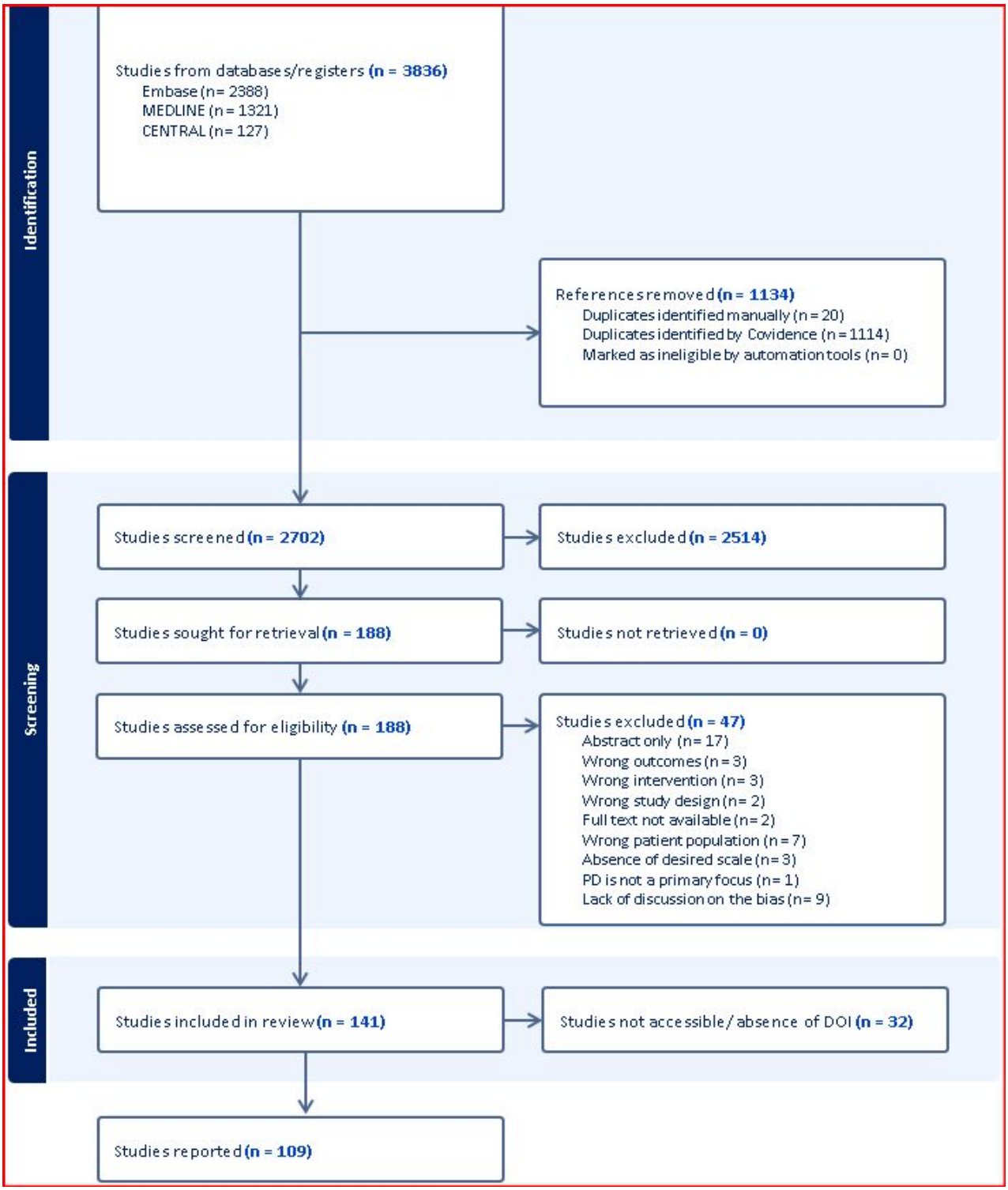


Figure 1. PRISMA flow diagram for study selection.

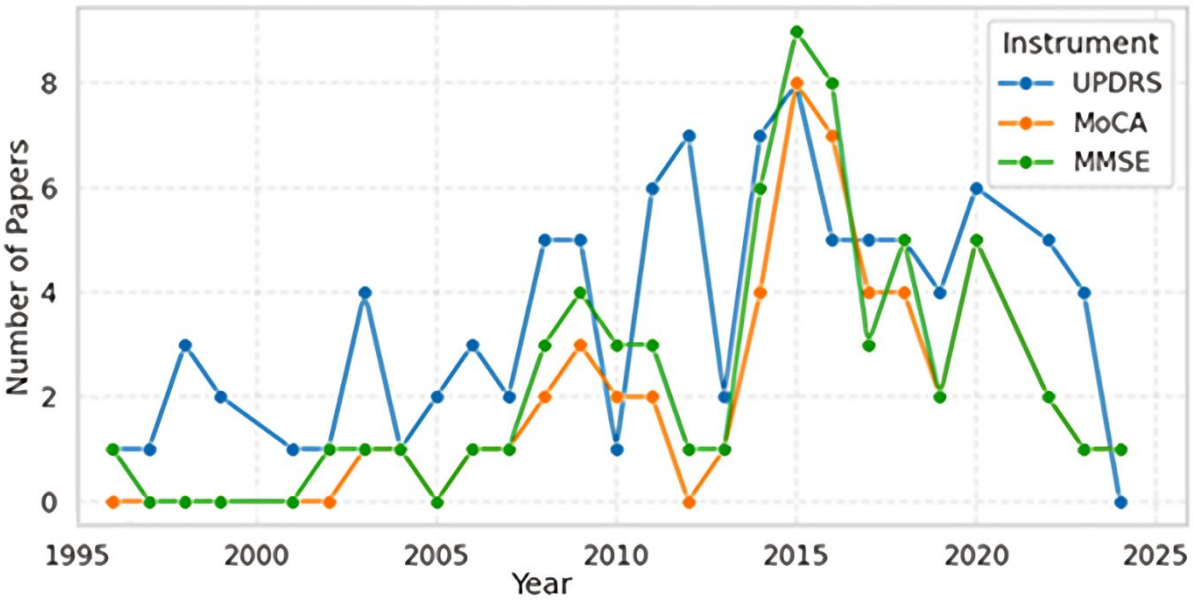


Figure 2. Publication Trends: UPDRS, MoCA, and MMSE (1996-2024)

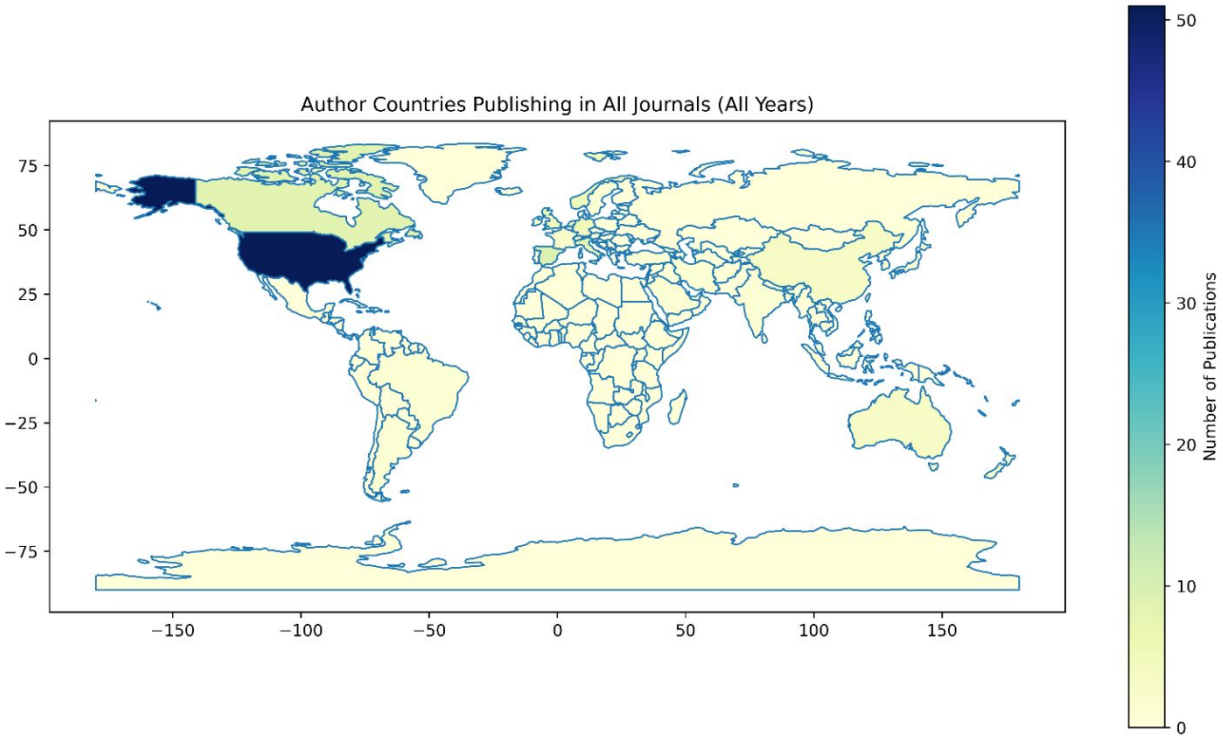


Figure 3. Author Countries Publishing in All journals (All Years)

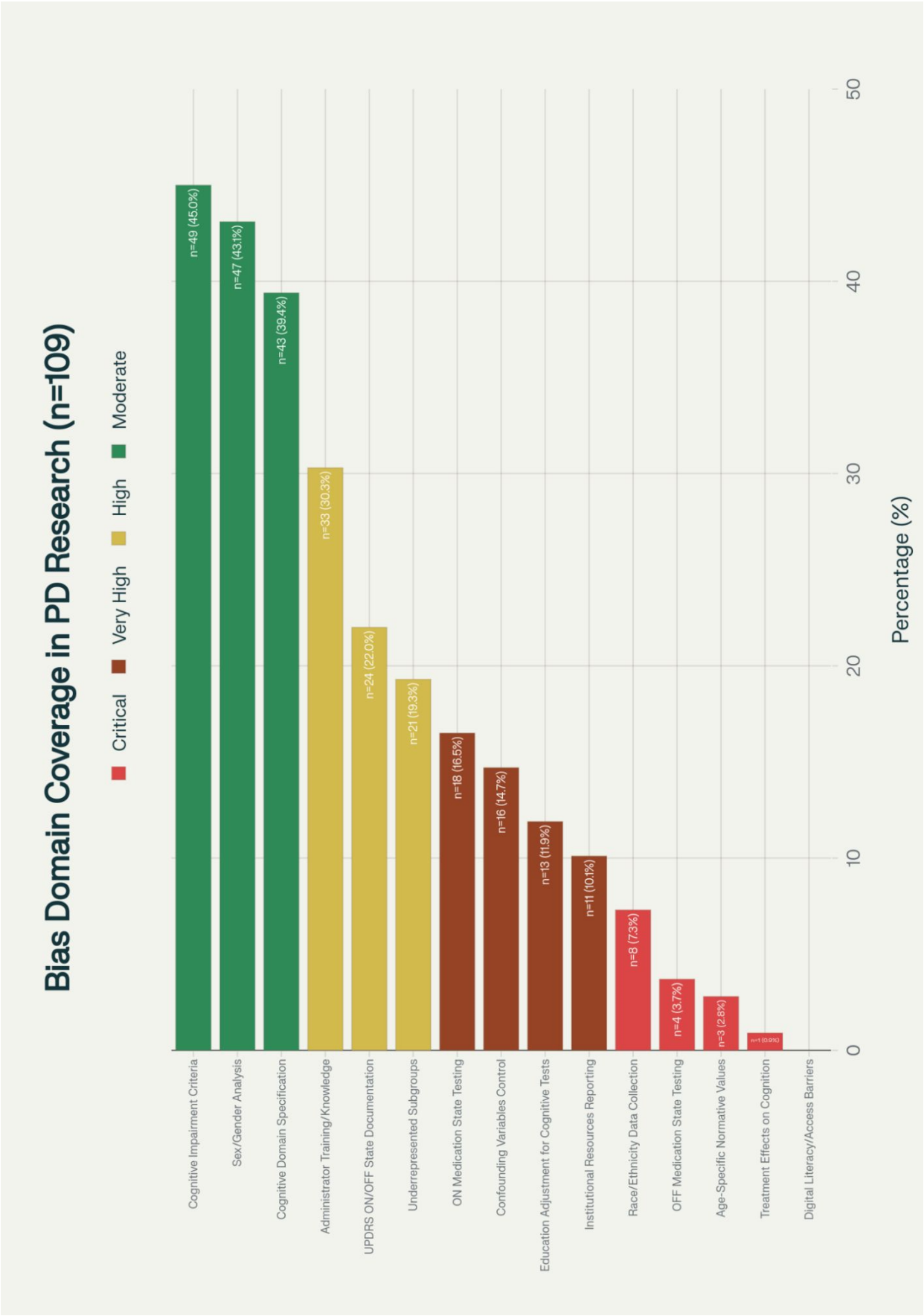
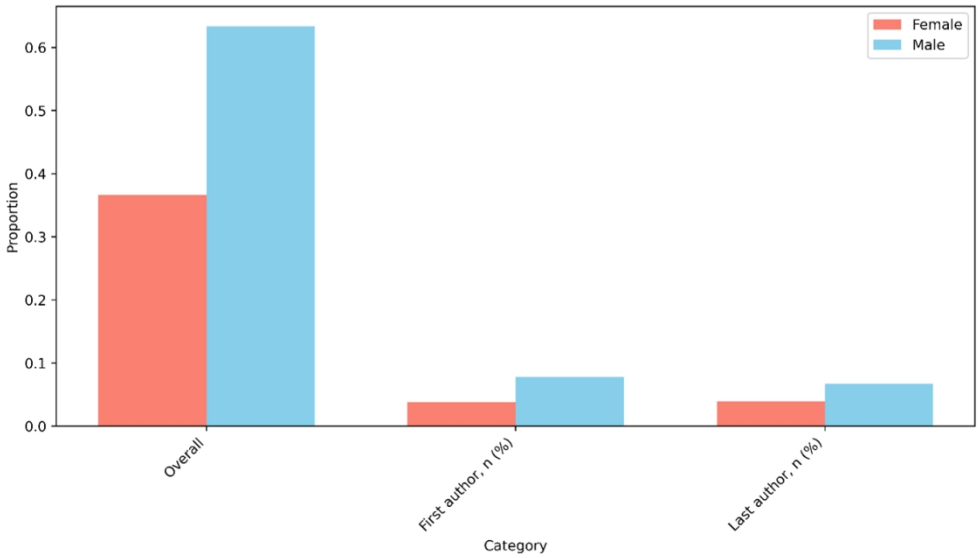

Bias Domain Coverage in PD Research (n=109)
Critical
Very High
High
Moderate
Percentage (%)
0
10
20
30
40
50
n=49 (45.0%)
n=47 (43.1%)
n=43 (39.4%)
n=33 (30.3%)
n=24 (22.0%)
n=21 (19.3%)
n=18 (16.5%)
n=16 (14.7%)
n=13 (11.9%)
n=11 (10.1%)
n=8 (7.3%)
n=4 (3.7%)
n=3 (2.8%)
n=1 (0.9%)
Cognitive Impairment Criteria
Sex/Gender Analysis
Cognitive Domain Specification
Administrator Training/Knowledge
UPDRS ON/OFF State Documentation
Underrepresented Subgroups
ON Medication State Testing
Confounding Variables Control
Education Adjustment for Cognitive Tests
Institutional Resources Reporting
Race/Ethnicity Data Collection
OFF Medication State Testing
Age-Specific Normative Values
Treatment Effects on Cognition
Digital Literacy/Access Barriers

Figure 4. Bias Domain Coverage in PD Assessment Scale Research

Bias Domain	Studies Addressing (n)	Percentage (%)	Risk Level
Education Adjustment for Cognitive Tests	13	11.9	Very High
Race/Ethnicity Data Collection	8	7.3	Critical
Treatment Effects on Cognition	1	0.9	Critical
Institutional Resources Reporting	11	10.1	Very High
Digital Literacy/Access Barriers	0	0.0	Critical
Age-Specific Normative Values	3	2.8	Critical
Administrator Training/Knowledge	33	30.3	High
UPDRS ON/OFF State Documentation	24	22.0	High
Sex/Gender Analysis	47	43.1	Moderate
Underrepresented Subgroups	21	19.3	High
ON Medication State Testing	18	16.5	Very High
OFF Medication State Testing	4	3.7	Critical
Cognitive Domain Specification	43	39.4	Moderate
Cognitive Impairment Criteria	49	45.0	Moderate
Confounding Variables Control	16	14.7	Very High

Table 1. Bias Domain Analysis Results (n=109)



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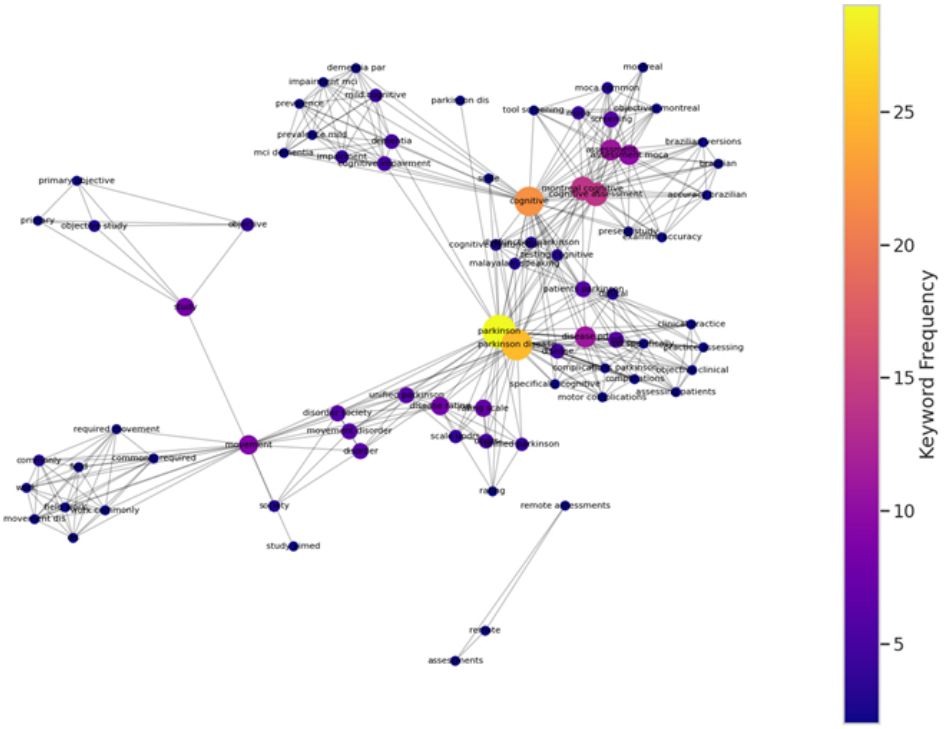
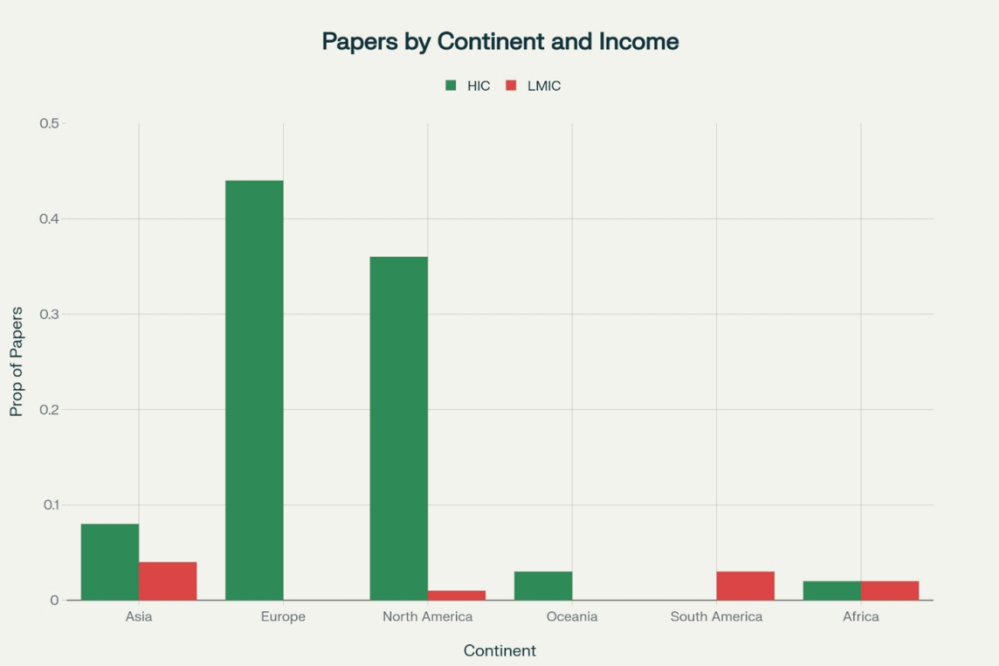


454x330mm (39 x 39 DPI)

408x215mm (47 x 47 DPI)



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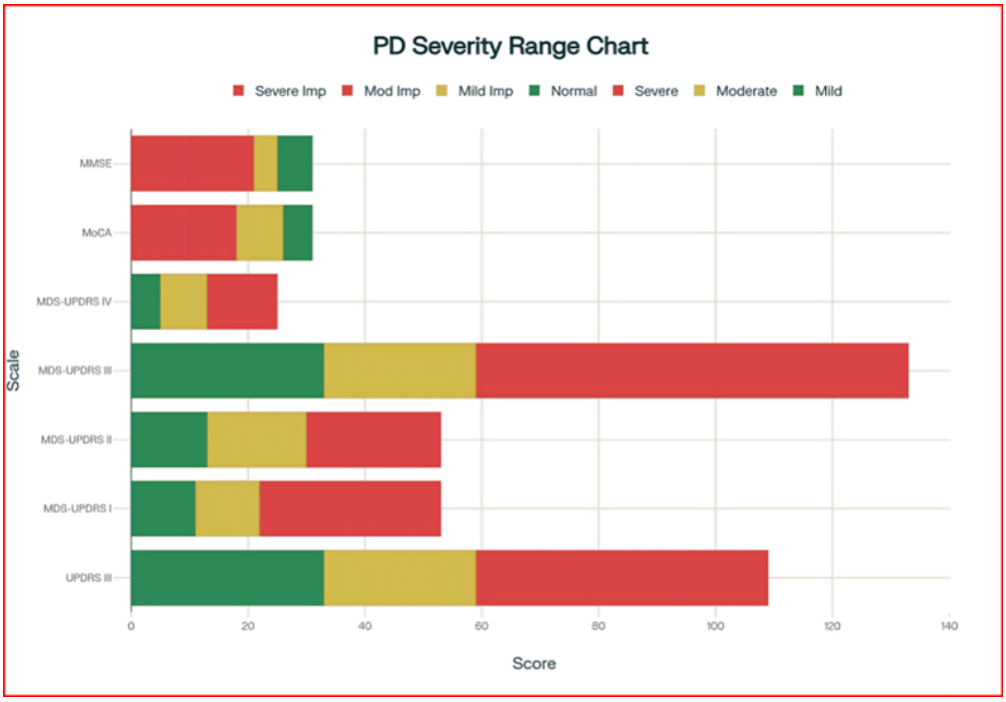

428x296mm (47 x 47 DPI)

	JOURNAL TITLE	COUNTS
1.	Movement Disorders	29
2.	Parkinsonism & Related Disorders	11
3.	Movement Disorders Clinical Practice	5
4.	Neurology	5
5.	Neurological Sciences	4
6.	Journal of Neurology	4
7.	Journal of Parkinson's Disease	4
8.	International Journal of Geriatric Psychiatry	2
9.	American Journal of Alzheimer's Disease & Othe...	2
10.	European Journal of Neurology	2
11.	Revue Neurologique	2
12.	The Clinical Neuropsychologist	2
13.	Parkinson's Disease	2
14.	Neurología (English Edition)	2
15.	Aging Clinical and Experimental Research	1
16.	Health Informatics Journal	1
17.	Frontiers in Neurology	1
18.	Digital Biomarkers	1
19.	Dementia and Geriatric Cognitive Disorders Extra	1
20.	Clinical Parkinsonism & Related Disorders	1
21.	Dementia & Neuropsychologia	1
22.	Clinical Neuropharmacology	1
23.	Brain and Cognition	1
24.	Alzheimer Disease & Associated Disorders	1
25.	Assessment	1
26.	Archives of Clinical Neuropsychology	1
27.	Applied Neuropsychology Adult	1
28.	International Journal of Speech-Language Patho...	1
29.	JAMA Neurology	1
30.	IEEE Transactions on Neural Systems and Rehabi...	1
31.	Health and Quality of Life Outcomes	1
32.	Journal of the Neurological Sciences	1
33.	Journal of the American Geriatrics Society	1
34.	Journal of Neurology Neurosurgery & Psychiatry	1
35.	Journal of Movement Disorders	1
36.	Journal of Clinical Neurology	1
37.	Journal of Clinical Neuroscience	1
38.	Journal of Advanced Nursing	1
39.	Journal of Clinical Medicine	1
40.	Ideggyógyászati Szemle	1
41.	Neurological Research	1
42.	Medical Image Analysis	1
43.	NeuroRehabilitation An International Interdisc...	1
44.	Neurologia i Neurochirurgia Polska	1
45.	Neurology India	1
46.	PLOS ONE	1
47.	Value in Health	1

531x752mm (79 x 79 DPI)

Region	Publications (n)	Percentage (%)	Income Level
Europe (HIC)	48	44.0	High
North America (HIC)	39	35.8	High
Asia (HIC)	9	8.3	High
Asia (LMIC)	4	3.7	LMIC
Oceania (HIC)	3	2.8	High
South America (LMIC)	3	2.8	LMIC
Africa (LMIC)	2	1.8	LMIC
North America (LMIC)	1	0.9	LMIC

446x216mm (47 x 47 DPI)

Characteristic	Value
Total papers analyzed	109
Publication period	1996-2024
Total authors examined	655
Countries represented	34
Journals represented	47
Most common assessment scales	UPDRS, MDS-UPDRS, MoCA, MMSE

467x169mm (47 x 47 DPI)