**INTRODUCTION**

Parkinson's disease (PD) is the second most common chronic neurodegenerative disease after Alzheimer's disease (AD). In addition to its defining motor symptoms, PD is characterized by a diverse spectrum of non-motor symptoms (NMSs). Cognitive impairment is one of the most common NMSs, with PD patients at an approximately sixfold increased risk of cognitive impairment compared with the general population. This study aimed to determine the prevalence and affective correlates of SCD in de novo PD patients.

**Materials and Methods:** A total of 139 de novo PD patients underwent comprehensive neuropsychological evaluation. PD patients with SCD (PD-SCD) did not meet the diagnostic criteria for mild cognitive impairment in PD (PD-MCI) based on the Movement Disorder Society Level II Criteria and were defined by a Domain-5 Score ≥1 on the Non-Motor Symptoms Questionnaire. Affective symptoms were measured using the Hamilton Depression Scale (HAMD) and Hamilton Anxiety Scale (HAMA).

**Results:** In the de novo PD cohort, the prevalence of SCD was 28.1%. PD-SCD patients performed significantly better than PD-MCI patients on tests of five cognitive domains. The more commonly affected domains in PD-SCD patients were memory (28.2%) and attention/working memory (25.6%). Multivariable linear regression analysis revealed that PD-SCD was significantly associated with both HAMD (β = 4.518, 95% CI = 0.754–8.281, p = .019) and HAMA scores (β = 4.259, 95% CI = 1.054–7.464, p = .010). Furthermore, binary logistic regression analysis revealed that higher HAMD (OR = 1.128, 95% CI = 1.019–1.249, p = .020) and HAMA scores (OR = 1.176, 95% CI = 1.030–1.343, p = .017) increased the risk of PD-SCD.

**Conclusions:** Our findings suggest that SCD is highly prevalent in de novo PD patients. The presence of PD-SCD is suggestive of an underlying affective disorder.

**KEYWORDS**

anxiety, de novo Parkinson's disease, depression, prevalence, subjective cognitive decline
MATERIALS AND METHODS

2.1 | Participants

A total of 139 de novo PD patients were recruited from the Affiliated Brain Hospital of Nanjing Medical University between 2018 and 2022. The inclusion criteria were as follows: newly diagnosed with PD according to the International Parkinson and Movement Disorder Society (MDS) clinical diagnostic criteria\(^\text{16}\), no antiparkinsonian drug treatment; in the early- or middle-stage of PD (modified Hoehn and Yahr [H-Y] stage ≤3); and successfully completed all clinical data evaluation. Exclusion criteria were a history of neurological diseases, psychiatric disorders, or serious medical conditions such as active malignancy and end-organ failure. All de novo PD patients enrolled were followed up for at least 1 year to confirm the diagnosis of PD based on the disease evolution and response to dopaminergic replacement therapy.

This study was approved by the Medical Ethics Committee of the Affiliated Brain Hospital of Nanjing Medical University (2015-KY030 and 2019-KY019-01) and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before participating in the study.

2.2 | Clinical evaluation

Demographic and clinical data were collected for the de novo PD patients. The demographic information included age, sex, formal education, age at PD onset, and disease duration. Motor evaluation included the Unified Parkinson’s Disease Rating Scale (UPDRS) part II, UPDRS part III, and modified H-Y stage. Based on Jankovic’s method,\(^\text{19}\) PD patients were divided into tremor-dominant (TD), indeterminate, and postural instability and gait difficulty (PIGD) subtypes. NMSs were comprehensively assessed using the Non-Motor Symptoms Questionnaire (NMSQuest), and NMSQuest domain-5 contains two questions to assess memory and attention.\(^\text{20}\) Sleep problems were assessed using the Parkinson’s Disease Sleep Scale (PDSS). Affect was evaluated using the Hamilton Depression Scale (HAMD) and Hamilton Anxiety Scale (HAMA).

Global cognition was measured using the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment Scale (MoCA). To adjust for education, a patient’s MoCa score (if <30) was increased by 1 point if they had ≤12 years of education.\(^\text{22}\) Various neuropsychological tests were administered to assess the five cognitive domains: the Digit Span Test (DST), Trail Making Test A (TMT-A), and Stroop Color-Word Test (SCWT) to assess attention/working memory; the Trail Making Test B (TMT-B), Clock Drawing Test (CDT), and Animal Fluency Test (AFT) to assess executive function; the Wechsler Adult Intelligence Scale III (WAIS-III) Similarities Test and Boston Naming Test (BNT) to assess language; the Auditory Verbal Learning Test (AVLT) and Logical Memory Test (LMT) to assess memory; and Benton’s Judgment of Line Orientation Test (ULOT) and the Hooper Visual Organization Test (HVOT) to assess visuospatial function.

2.3 | Cognitive classifications

PD patients were further categorized as PD with normal cognition (PD-NC), PD-SCD, and PD with mild cognitive impairment (PD-MCI). PD-MCI was defined by the MDS Level II diagnostic criteria\(^\text{23}\) in which scores for at least two neuropsychological tests, whether in the same cognitive domain or different cognitive domains, are 1.5 standard deviations (SDs) below the average correcting for age, sex, and education. PD patients who did not meet the diagnostic criteria for PD-MCI were categorized as PD-SCD or PD-NC according to NMSQuest Domain-5. PD-SCD was defined as an NMSQuest Domain-5 score ≥1, similar to previous studies.\(^\text{8,14,24}\)

2.4 | Statistical analysis

Demographic and clinical characteristics were reported as frequency (percent) for categorical variables and the median±SD for continuous variables. The Shapiro-Wilk test and Kolmogorov-Smirnov test were used to assess the normality of the data. Continuous variables were compared between the PD-NC, PD-SCD, and PD-MCI groups using one-way analysis of variance.
(ANOVA) or the Kruskal–Wallis H-test depending on the normality of the data, while categorical variables were compared using the Chi-square test, followed by post hoc analysis with Bonferroni correction. Multivariant linear regression analysis and binary logistic regression analysis were performed to investigate any bidirectional relationship between the presence of PD-SCD and affective symptoms, controlling for age, sex, and disease duration as potential confounders. Two-tailed p-values < .05 were considered statistically significant. All statistical analyses were performed using SPSS version 25.0 (SPSS, Inc.).

3 | RESULTS

3.1 | Demographic and clinical features

The demographic and clinical characteristics of the 139 de novo PD patients are summarized in Table 1. The mean age was 56.5 years and the mean disease duration was 1.9 years. The stratification resulted in 27 patients (19.4%) in the PD-NC group, 39 patients (28.1%) in the PD-SCD group, and 73 patients (52.5%) in the PD-MCI group. There were no significant differences between the three groups in demographic, motor characteristics or motor subtypes, other than UPDRS part III. The post hoc analysis indicated that PD-MCI patients had more severe UPDRS motor scores than PD-NC patients. Furthermore, there were significant differences between the three groups in terms of NMSs. Compared with PD-NC patients, PDSS and HAMA scores were more severe in PD-MCI patients, while NMSQuest, HAMD, and HAMA scores were more severe in PD-SCD patients.

3.2 | Cognitive performance

Table 2 compares the global cognition and comprehensive neuropsychological test scores between the PD-NC, PD-SCD, and PD-MCI groups. Statistically significant differences between the three groups were observed for all measures except SCWT-A-right and SCWT-C-right. Post hoc analysis revealed that PD-MCI patients performed significantly worse than PD-NC patients on global cognition, attention/working memory (except SCWT-right), executive function, language, memory (except AVLT-recognition), and visuospatial function. In addition, PD-SCD patients performed significantly better than PD-MCI patients on global cognition (except MMSE), attention/working memory (except SCWT-right), executive function, language, memory, and visuospatial function.

### Table 1 Demographic and clinical characteristics of the PD-NC, PD-SCD, and PD-MCI groups

| Variables              | Total (n = 139, 100%) | PD-NC (n = 27, 19.4%) | PD-SCD (n = 39, 28.1%) | PD-MCI (n = 73, 52.5%) | p      | Post hoc |
|------------------------|-----------------------|-----------------------|------------------------|------------------------|--------|----------|
| Age (years)            | 56.5 ± 7.9            | 54.1 ± 7.5            | 55.9 ± 8.8             | 57.6 ± 7.4             | .134   |          |
| Sex, Male (%)          | 70 (50.4)             | 17 (63.0)             | 22 (56.4)              | 31 (42.5)              | .128   |          |
| Formal education (years)| 10.5 ± 3.4            | 11.3 ± 4.0            | 11.2 ± 3.1             | 9.9 ± 3.3              | .076   |          |
| Age at onset (years)   | 54.6 ± 8.1            | 52.4 ± 7.3            | 53.9 ± 9.3             | 55.8 ± 7.5             | .133   |          |
| Disease duration (years)| 1.9 ± 1.5             | 1.8 ± 1.3             | 2.4 ± 1.9              | 1.8 ± 1.3              | .119   |          |
| UPDRS part II          | 6.9 ± 3.5             | 6.0 ± 3.3             | 7.5 ± 3.6              | 6.9 ± 3.6              | .229   |          |
| UPDRS part III         | 19.7 ± 9.5            | 16.5 ± 9.5            | 18.3 ± 8.3             | 21.7 ± 9.8             | .028   | 0.044a   |
| H-Y stage              | 1.6 ± 0.5             | 1.5 ± 0.4             | 1.6 ± 0.5              | 1.6 ± 0.5              | .579   |          |
| Motor subtype          |                       |                       |                        |                        |        |          |
| TD (%)                 | 31 (22.3)             | 4 (14.8)              | 11 (28.2)              | 16 (21.9)              | .580   |          |
| PIGD (%)               | 22 (15.8)             | 20 (74.1)             | 23 (59.0)              | 43 (58.9)              |        |          |
| Indeterminate (%)      | 86 (61.9)             | 3 (11.1)              | 5 (12.8)               | 14 (19.2)              |        |          |
| NMSQuest               | 7.4 ± 4.3             | 5.7 ± 2.6             | 8.6 ± 4.5              | 7.5 ± 4.6              | .026   | 0.020b   |
| PDSS                   | 126.9 ± 21.1          | 134.3 ± 20.9          | 124.0 ± 24.4           | 125.7 ± 18.8           | .021   | 0.018a   |
| HAMD                   | 9.4 ± 6.8             | 6.2 ± 3.8             | 11.3 ± 9.0             | 9.5 ± 6.0              | .028   | 0.037b   |
| HAMA                   | 6.6 ± 5.5             | 4.0 ± 2.8             | 8.4 ± 7.8              | 6.7 ± 4.4              | .022   | 0.031a, 0.040b |

Note: Data are shown as the mean ± SD or n (%). p-values were calculated using analysis of variance, Kruskal–Wallis H-test, or Chi-square test followed by post hoc analysis with Bonferroni adjustment. Statistically significant values (p < .05) are presented in bold.

Abbreviations: HAMA, Hamilton anxiety scale; HAMD, Hamilton depression scale; H-Y, Hoehn and Yahr; NMSQuest, non-motor symptoms questionnaire; PD, Parkinson’s disease; PD-MCI, Parkinson’s disease with mild cognitive impairment; PD-NC, Parkinson’s disease with normal cognition; PD-SCD, Parkinson’s disease with subjective cognitive decline; PDSS, Parkinson’s disease sleep scale; PIGD, postural instability and gait difficulty; TD, tremor-dominant; UPDRS, unified Parkinson’s disease rating scale.

aStatistically significant difference between the PD-NC and PD-MCI groups.
bStatistically significant difference between the PD-NC and PD-SCD groups.
### Cognitive performance among the PD-NC, PD-SCD, and PD-MCI groups

| Variables       | Total (n = 139, 100%) | PD-NC (n = 27, 19.4%) | PD-SCD (n = 39, 28.1%) | PD-MCI (n = 73, 52.5%) | p      | Post hoc |
|-----------------|------------------------|-----------------------|------------------------|------------------------|--------|----------|
| **Global cognition** |                        |                       |                        |                        |        |          |
| MMSE            | 27.7 ± 2.3             | 28.2 ± 3.1            | 28.2 ± 1.4             | 27.3 ± 2.3             | .005   | <.001a, <.001b |
| MoCA            | 24.1 ± 3.4             | 25.7 ± 2.7            | 25.7 ± 3.0             | 22.8 ± 3.3             | <.001  |          |
| **Attention/working memory** |            |                       |                        |                        |        |          |
| DST             | 12.0 ± 2.3             | 12.7 ± 2.2            | 12.4 ± 1.9             | 11.4 ± 2.5             | .011   | .047b, .043b |
| TMT-A (second)  | 90.9 ± 46.7            | 68.4 ± 24.0           | 71.9 ± 24.0            | 109.3 ± 54.1           | <.001  | <.001b, <.001b |
| SCWT-A-time (second) | 28.1 ± 9.4            | 24.2 ± 4.6            | 25.5 ± 7.0             | 30.9 ± 10.9            | .006a, 0.006b |
| SCWT-B-time (second) | 40.2 ± 14.7        | 34.0 ± 9.1            | 35.1 ± 8.7             | 45.3 ± 17.0            | <.001  | 0.001a, 0.001b |
| SCWT-C-time (second) | 74.3 ± 28.1          | 65.8 ± 20.4           | 65.5 ± 18.3            | 82.2 ± 32.5            | <.001  | 0.007a, 0.001b |
| SCWT-A-right     | 50.0 ± 0.9             | 50.0 ± 0.0             | 49.9 ± 0.3             | 50.0 ± 1.2             | .379   |          |
| SCWT-B-right     | 49.2 ± 2.0             | 49.8 ± 0.4             | 49.5 ± 1.3             | 48.7 ± 2.5             | .021   |          |
| SCWT-C-right     | 47.6 ± 4.1             | 48.5 ± 2.4             | 48.2 ± 3.4             | 47.0 ± 4.8             | .150   |          |
| **Executive function** |                  |                       |                        |                        |        |          |
| TMT-B (second)   | 189.1 ± 99.8           | 137.8 ± 39.4          | 152.6 ± 30.9           | 227.5 ± 121.7          | <.001  | <.001b, <.001b |
| CDT              | 8.7 ± 2.2              | 9.9 ± 0.4              | 9.6 ± 1.1              | 7.8 ± 2.6              | <.001  | <.001b, <.001b |
| AFT              | 18.4 ± 5.3             | 20.7 ± 4.9             | 20.4 ± 3.8             | 16.5 ± 5.5             | <.001  | <.001b, <.001b |
| **Language**     |                        |                       |                        |                        |        |          |
| Similarities     | 16.3 ± 4.7             | 18.1 ± 4.6             | 18.1 ± 4.0             | 14.7 ± 4.5             | <.001  | 0.002a, 0.001b |
| BNT              | 23.7 ± 3.9             | 25.5 ± 2.7             | 25.5 ± 2.4             | 22.1 ± 4.3             | <.001  | <.001b, <.001b |
| **Memory**       |                        |                       |                        |                        |        |          |
| AVLT-delayed recall | 5.2 ± 2.5             | 6.3 ± 2.2              | 6.4 ± 1.9              | 4.2 ± 2.4              | <.001  | <.001b, <.001b |
| AVLT-recognition | 21.6 ± 2.7             | 22.0 ± 1.8             | 22.4 ± 1.6             | 21.0 ± 3.3             | .014   | 0.015b   |
| LMT-delayed recall | 5.6 ± 2.6             | 6.8 ± 2.7              | 6.4 ± 2.4              | 4.7 ± 2.4              | <.001  | <.001a, 0.002b |
| **Visuospatial function** |            |                       |                        |                        |        |          |
| JLOT             | 24.2 ± 3.6             | 26.1 ± 2.9             | 25.4 ± 2.3             | 22.8 ± 3.8             | <.001  | <.001b, <.001b |
| HVOT             | 15.1 ± 4.8             | 18.2 ± 4.5             | 17.6 ± 3.4             | 12.6 ± 4.1             | <.001  | <.001b, <.001b |

Note: Data are shown as the mean ± SD. p-values were calculated using analysis of variance, Kruskal-Wallis H-test, or Chi-square test followed by post hoc analysis with Bonferroni adjustment. Statistically significant values (p < .05) are indicated in bold.

Abbreviations: AFT, animal fluence test; AVLT, auditory verbal learning test; BNT, boston naming test; CDT, clock drawing test; DST, digit span test; HVOT, hooper visual organization test; JLOT, benton's judgment of line orientation test; LMT, logical memory test; MMSE, mini-mental state examination; MoCA, montreal cognitive assessment; PD, Parkinson's disease; PD-MCI, Parkinson's disease with mild cognitive impairment; PD-NC, Parkinson's disease with normal cognition; PD-SCD, Parkinson's disease with subjective cognitive decline; SCWT, stroop color-word test; TMT-A, trail making test A; TMT-B, trail making test B.

aStatistically significant difference between the PD-NC and PD-MCI groups.
bStatistically significant difference between the PD-SCD and PD-MCI groups.

Subsequently, we compared the frequency of cognitive domain deficits in the three groups (Figure 1). The cognitive domains commonly impaired in the PD-SCD group were memory (28.2%) and attention/working memory (25.6%), whereas the domains commonly impaired in the PD-MCI group were attention/working memory (74.0%) and executive function (72.6%). The frequencies of deficits in the five cognitive domains were significantly different among the three groups. Post hoc analysis indicated that PD-MCI patients had a higher frequency of impairment in all domains except language compared with PD-NC and PD-SCD patients (p < .001).

### 3.3 Association between PD-SCD presence and affective symptoms

We explored whether PD-SCD presence was bidirectionally related to affective symptoms while controlling for age, sex, and disease duration (Table 3). The results of the multivariable linear regression analysis indicated that SCD was significantly associated with worse HAMD scores (β = 4.518, 95% CI = 0.754-8.281, p = .019) and HAMA scores (β = 4.259, 95% CI = 1.054-7.464, p = .010). According to the binary logistic regression analysis, higher HAMD scores (OR = 1.128,
The presence of PD-SCD in an overall intact PD patient may denote a stage of cognitive decline between PD-NC and PD-MCI, as has been confirmed in the ordinary population. In preclinical AD patients, SCD has been shown to increase the risk of transition to dementia. Similarly, the presence of PD-SCD was highlighted as a risk factor for PD-MCI in recent longitudinal follow-up studies. Thus, PD-SCD is a promising concept with the potential to enable early diagnosis of impending cognitive impairment.

The prevalence of MCI in this study was 52.5%, which is higher than the reported 40% prevalence in a recent meta-analysis. This discrepancy may be primarily due to our use of a schedule of 12 cognitive evaluations spanning five cognitive domains. In addition, PD-MCI was associated with more severe motor symptoms. The PD patients enrolled in this study were not taking antiparkinsonian drugs and motor symptoms may affect cognitive assessments, especially assessment of executive function, leading to an increased prevalence of MCI.

The prevalence of SCD was 28.1% in our de novo PD cohort, which is slightly higher than previous findings. This may be due to heterogeneity in assessing PD-SCD questions. This study used a more sensitive test, namely the NMSQuest Domain-5, to assess memory and attention function, whereas most previous studies assessed memory complaints using a single question of the NMSQuest, the first item of the UPDRS, or questionnaires such as the Cognitive Complaints Interview (CCI), Memory Assessment Clinics Questionnaire (MAC-Q), and Parkinson’s Disease Cognitive Questionnaire (PD-CQ). While some studies have used questionnaires encompassing the five cognitive domains to determine the presence of PD-SCD, these instruments require further validation. The PD-SCD group also had higher NMSQuest scores than the PD-NC group, which was mainly attributed to the fact that the PD-SCD and PD-NC groups were grouped based on NMSQuest Domain-5.

In terms of cognitive performance, PD-SCD patients outperformed PD-MCI patients in the five cognitive domains. As the PD-SCD patients in this study did not have objective cognitive impairment, it is not difficult to understand why PD-SCD patients had better cognitive performance than PD-MCI patients. Additionally, we found that the cognitive domains commonly affected in the PD-SCD patients were memory and attention/working memory, which is consistent with the results of a previous study. As the concept of SCD is based on research in AD patients as a generic description of early experienced cognitive deficits, and memory is the main cognitive domain impaired in AD, concerns about memory impairment may have biased studies of PD-SCD to some extent. In view of the range of cognitive deficits in non-demented PD patients, it is important to place a broad emphasis on cognitive complaints rather than memory complaints specifically in early PD. Previous studies have demonstrated that changes in the attention/working memory domain already exist in the prodromal stage of PD, and that attention/working memory is the most commonly affected domain in de novo PD patients. Therefore, as research on PD-SCD continues to progress, it should become more standardized and focus on PD-specific cognitive deficits such as attention/working memory function.
The presence of SCD in the newly diagnosed PD patients in this study was associated with higher depression and anxiety scores and showed a bidirectional relationship, which is similar to previous reports.\textsuperscript{8,13-15} As some studies have found no relationship between SCD and mood disorders,\textsuperscript{16,17} and have even proposed a link between objective cognitive impairment and affective symptoms,\textsuperscript{15,40} this link remains controversial. This discrepancy may arise because PD-SCD samples are highly heterogeneous. With an established definition of PD-SCD, samples will become more homogeneous and the relationship between SCD and mood can be studied more thoroughly. Furthermore, although we describe a cross-sectional relationship between SCD and mood disorders, our findings suggest that PD-SCD is suggestive of mood disorders. As depression and anxiety are well-established risk factors for MCI in early PD,\textsuperscript{44} further studies are needed to determine whether PD-SCD patients with affective symptoms have subthreshold cognitive decline and an increased risk of subsequently developing PD-MCI.

The strength of this study lies in the use of a new definition of SCD to examine its prevalence and affective (depression and anxiety) correlates in patients with de novo PD. Nevertheless, this study is subject to some limitations. First, the NMSQuest Domain-5 assesses memory and attention domains, not all five cognitive domains thought to be impaired in PD-MCI. However, there is currently a lack of consensus on assessment instruments for PD-SCD. Therefore, there is a need for a multi-cognitive domain, standardized, and sufficiently reliable tool to assess SCD in PD patients. Second, due to the cross-sectional study nature of this study, an association between PD-SCD presence and affective symptoms can only be demonstrated. Longitudinal follow-up studies are thus essential to establish causation between PD-SCD and affective symptoms. This work is part of a longitudinal study of de novo PD patients and we will expedite follow-up of these patients. Third, although we examined depression and anxiety symptoms associated with SCD, we did not examine other psychiatric symptoms (e.g., apathy) or possible confounders (e.g., family history of dementia) as potential factors for SCD. As studies have shown that apathy is associated with PD-SCD,\textsuperscript{8} future studies should investigate potential associations between these factors and PD-SCD.

5 | CONCLUSION

The findings of this study suggest that SCD is highly prevalent in de novo PD patients and that the presence of PD-SCD is suggestive of underlying depression and anxiety disorders. Careful evaluation of affective symptoms is necessary for optimal management and treatment of PD-SCD patients. Longitudinal studies will be essential to confirm and expand the relationship between PD-SCD and mood symptoms.

AUTHOR CONTRIBUTIONS

JT and WL organized the project. NY drafted the preliminary manuscript and performed statistical analysis. YJ, JR, and HW collected the data. PL and HN critically revised the manuscript. All listed authors contributed to this article and approved the submitted version for publication.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

Raw data for this study are available from the corresponding authors upon reasonable request.

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