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Managing non-motor symptoms of Parkinson disease in China: clinical perspectives

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Abstract

Background Parkinson's disease (PD) is a complex neurodegenerative disorder with both motor and non-motor symptoms (NMS), the latter having a profound impact on patients' quality of life (QoL). Increased recognition of NMS underscores the need for comprehensive approaches. The study aimed to evaluate healthcare professionals' awareness and management practices of NMS in PD in China.

Methods A nationwide online survey was conducted among 913 neurologists and psychiatrists from July to October 2023. The questionnaire comprised 65 closed-ended questions addressing basic demographics, awareness, assessment, and treatment strategies for NMS in PD. Chi-square tests were used to analyze differences between the two professional groups.

Results While 95.4% of respondents acknowledged the negative impact of NMS on PD patients' QoL, only 71.0% of neurologists regularly focused on NMS. Approximately half of the NMS were inadequately addressed, with attention to NMS often beginning in the middle to late stages of PD. Significant gaps were identified in awareness and treatment, particularly in managing depression/anxiety, cognitive impairment, and psychotic symptoms. Movement disorder specialists demonstrated higher levels of awareness and management proficiency for NMS.

Conclusions The study highlights critical gaps in NMS management for PD patients in China, underscoring the need for improved early recognition and appropriate intervention.

Keywords Parkinson's disease, Non-motor symptoms, Clinical practice, China, Survey study

Introduction

Parkinson's disease (PD) is a prevalent neurodegenerative disorder causing substantial disability and posing a global public health challenge due to its motor and non-motor symptoms (NMS) [1]. According to the 2016 Global Burden of Disease Study, Chinese patients make up approximately 23% of the global PD population. By 2030, China is projected to account for half of the world's PD cases, underscoring the rapidly growing burden of this disease [2]. The rising prevalence of PD in China underscores the urgent need for the healthcare system to adapt and prepare for this increasing burden. Effective management strategies and integrated multidisciplinary care models

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are essential to support patients and caregivers while mitigating the disease impact on the healthcare system. Our study examined current clinical practices to identify key systemic improvements and support comprehensive patient care.

In addition to motor symptoms, PD is marked by a range of NMS, including cognitive impairment, depression, psychotic symptoms, autonomic dysfunction, sleep disturbances, hyposmia, pain, and others. These NMS can manifest years before the onset of motor symptoms and serve as key predictors of disease progression [3–5]. The impact of NMS on quality of life (QoL) often exceeds that of motor symptoms [3], emphasizing the critical need for early detection and heightened awareness of these symptoms. Over the past two decades, international PD guidelines have increasingly recognized the importance of managing NMS [6–9]. Furthermore, several studies have explored the clinical characteristics of NMS in Chinese PD patients [2, 10, 11]. However, limited data exists on the current practices and perspectives among Chinese neurologists regarding the recognition, evaluation, and treatment of PD-related NMS. To address this gap, we conducted a nationwide survey in China, employing a clinical questionnaire to assess neurologists' and psychiatrists' perceptions and practices regarding NMS in PD.

Methods

Questionnaire design

We developed an anonymous survey consisting of 65 closed-ended questions to comprehensively assess healthcare professionals' awareness and clinical practices related to NMS in PD. The questionnaire addressed key areas, including: basic demographics and professional background of participants; overall attention and approaches to NMS; awareness, diagnosis, and treatment practices for specific NMS, such as depression/anxiety, cognitive impairment/dementia, hallucinations/delusions, sleep disorders, olfactory impairment, and pain; estimates of NMS onset and prevalence; commonly used assessment tools; views on the effectiveness of medications; and perspectives on the impact of NMS on PD severity and QoL.

The survey was conducted online between July and October 2023. The questionnaire was strategically disseminated through professional medical networking platforms and provincial medical associations, utilizing a stratified approach to ensure comprehensive geographical representation across the 34 administrative divisions of China. The participants included neurologists, psychiatrists, and neurosurgeons at various career stages (resident, attending, associate chief, and chief physicians), as well as nurses.

Respondents were classified into five categories based on their specialties and subspecialties:

1. Movement disorder specialists: Neurologists with additional training in movement disorders, regularly attending movement disorder clinics.
2. General neurologists: Neurologists with a broader focus on neurology, without a specific focus on movement disorders.
3. Psychiatrists.
4. Neurosurgeons.
5. Nurses: nurses working in neurology and psychiatry wards.

We stratified neurologists into two distinct groups: movement disorder specialists and general neurologists. Subsequent analyses were conducted both within these subgroups and across the composite neurologist population (defined as the aggregate of both specialty classifications). Furthermore, we divided the composite neurologist population into two groups for analysis: those who have read the guidelines and those who have not.

Questionnaires meeting the following criteria were classified as invalid and were excluded:

1. The actual completion time was less than 50% of the average completion time for the entire population or exceeded three times the average completion time.
2. The completion rate was below 50%.
3. Other cases deemed invalid by evaluators, such as selecting the same option for five or more consecutive questions.

Statistics

Categorical variables were presented as frequencies and percentages. The chi-square test was used to analyze differences in awareness, drug treatments, and rehabilitation strategies between the subgroups. A P-value of less than 0.05 was considered statistically significant. All statistical analyses were conducted using STATA version 17 software.

Results

Overview

We collected 1,350 questionnaires, with 913 valid responses included in the final analysis after screening, as shown in Figure S1. Due to low response rates and insufficient valid questionnaires (12 out of 123 from nurses and 6 out of 28 from neurosurgeons), data from both nurses and neurosurgeons were excluded from the final analysis. The geographical distribution of respondents across Chinese provinces and municipalities is depicted

Table 1 Demographic and general information

Category	Number	Percentage (%)
Sex		
Male	464	50.8%
Female	449	49.2%
Levels of hospital		
Tertiary general hospital	760	83.2%
Secondary general hospital	83	9.1%
Psychiatric specialty hospital	56	6.1%
Community hospital	14	1.5%
Professional title		
Chief Physician	259	28.4%
Associate Chief Physician	254	27.8%
Attending Physician	243	26.6%
Resident Physician	157	17.2%
Specialty		
Movement disorder specialty	595	65.2%
General Neurologist	259	28.4%
Psychiatrist	59	6.5%
Monthly number of PD patients seen		
Basically none	517	56.6%
Less than 10 cases	236	25.8%
10–30 cases	97	10.6%
More than 30 cases	63	6.9%

Abbreviation: PD, Parkinson's disease

in Figure S2. Table 1 summarizes the demographic characteristics and general information of the participants.

Awareness and evaluation of NMS in PD by neurologists

The vast majority of respondents (95.4%) acknowledged the negative impact of NMS on PD patients' QoL, while 71.0% of the composite neurologist population reported regularly focusing on NMS in PD (Fig. 1). However, approximately half of the NMS were inadequately addressed, with weight loss and sexual dysfunction receiving the least attention - each being addressed by less than 30% of the composite neurologist population. (Fig. 1). Moreover, attention to NMS often began late, as nearly half of the composite neurologist population only addressed these symptoms in the middle to late stages of PD (Fig. 2). The movement disorder specialists initiated NMS assessment in PD earlier than general neurologists (proportion of NMS assessment in early to mid-stage PD, 89.2% vs. 72.0%, $p < 0.0001$) (Table 2, Table S1). Similarly, guideline-informed neurologists demonstrated earlier detection of NMS compared to their uninformed counterparts (proportion of NMS assessment in early to mid-stage PD, 81.1% vs. 62.1%, $p < 0.0001$) (Table 2, Table S1).

The survey also highlighted knowledge gaps regarding the prevalence of key NMS, with less than half of the composite neurologist population accurately identifying the rates of depression (48.6%), cognitive impairment (44.9%), and psychotic symptoms (33.7%). Furthermore, only 32% of the composite neurologist population were aware of the early executive function impairments associated with PD. The utilization of assessment tools for NMS was also sub-optimal, with only 65.8% of the composite neurologist population employing them (Table S2). Notably, movement disorder specialists and guideline-informed neurologists demonstrated significantly increased rates of NMS assessment using auxiliary diagnostic methods ($p < 0.05$, Table S2).

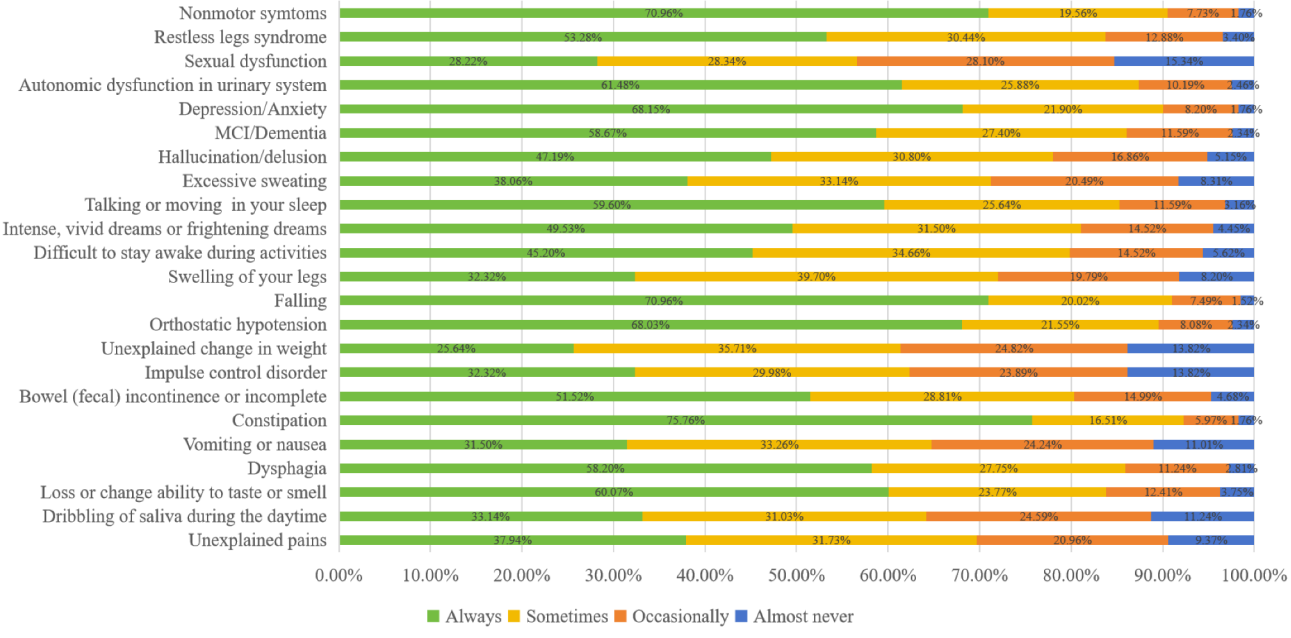

Fig. 1 How often the composite neurologist population pay attention to the non-motor symptoms associated with Parkinson's disease

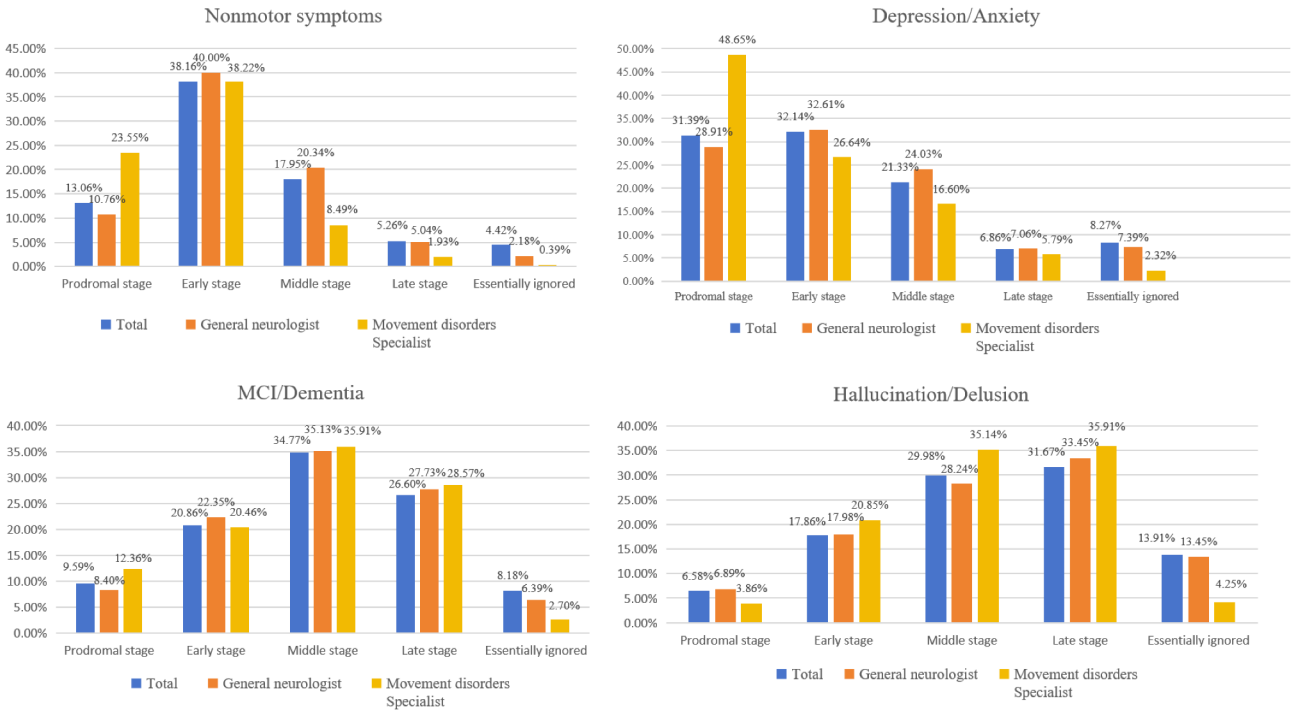

Fig. 2 From which disease stage do neurologists start to pay attention to the non-motor symptoms associated with Parkinson's disease

Table 2 From which disease stage do neurologists start to pay attention to the non-motor symptoms associated with Parkinson's disease

Item	Total	Specialty			Had or had not read guideline		
	(*n* = 854)	Movement disorder specialists (*n* = 259)	General neurologists (*n* = 595)	*p* value	Read (*n* = 693)	not read (*n* = 161)	*p* value
All non-motor symptoms							
Prodromal + Early, n(%)	662 (77.5)	231(89.2)	431(80.0)		562(81.1)	100(62.1)	< 0.0001
Middle + Late + unfollowed, n(%)	192(22.5)	28(10.8)	164(20.0)	< 0.0001	131(18.9)	61(37.9)	
Depression/anxiety							
Prodromal + Early, n(%)	561(65.7)	195(72.3)	366(61.5)		482(56.4)	79(49.1)	0.1004
Middle + Late + unfollowed, n(%)	293(34.3)	64(24.7)	229(38.5)	< 0.0001	372(43.6)	82(50.9)	
Cognitive impairment/dementia							
Prodromal + Early, n(%)	268(31.4)	85(32.8)	183(30.8)		235(33.9)	33(20.5)	0.0009
Middle + Late + unfollowed, n(%)	586(68.6)	174(67.2)	412(69.2)	0.5747	458(66.1)	128(79.5)	
Psychotic symptoms							
Prodromal + Early, n(%)	212(24.8)	64(24.7)	148(24.9)		180(26.0)	32(74.0)	0.1284
Middle + Late + unfollowed, n(%)	642(75.2)	195(75.3)	447(75.1)	> 0.9999	513(20.0)	129(80.0)	

Pharmacological and Non-Pharmacological treatment

The survey focused on the management of NMS, particularly depression/anxiety, cognitive impairment/dementia, and psychotic symptoms.

Depression/Anxiety Approximately 54.8% of the composite population of neurologists were unaware of the potential effects of certain dopamine receptor agonists (DAs), such as pramipexole. This lack of awareness may be one of the key reasons why only 33.1% of respondents selected DAs as their first chosen treatment for depression in PD (Table 3). A higher proportion of movement disorder specialists and guideline-informed neurologists opted for DAs in treating depression associated with PD (47.9% vs. 26.7%, $p < 0.001$, and 35.9% vs. 21.7%, $p < 0.05$). Overall, 1.6% of the composite neurologist population chose Chinese patent medicine treatment, with no significant difference observed between movement disorder specialists and general neurologists. For non-pharmacological treatments, 31.6% of the composite neurologist population reported using repetitive transcranial magnetic stimulation (rTMS) (Table 3). A non-invasive alternative to deep

Table 3 The treatment of psychiatric symptoms in patients with Parkinson's disease by the composite neurologist population

Item	Total	Specialty			Have or have not read the guideline		
		Movement disorder Specialists (*n* = 259)	General neurologists (*n* = 595)	*p* value	Read (*n* = 693)	Not read (*n* = 161)	*p* value
Depression/anxiety							
Dopamine agonists, n(%)	283(33.1)	124(47.9)	159(26.7)	< 0.001	248(35.8)	35(21.7)	0.001
SNRIs, n(%)	123(14.4)	38(14.7)	85(14.3)	0.883	104(15.0)	19(11.8)	0.297
SSRIs, n(%)	326(38.1)	75(29.0)	251(42.2)	< 0.001	268(38.7)	58(36.0)	0.533
NaSSAs, n(%)	31(3.6)	9(3.5)	22(3.7)	0.873	29(4.2)	2(1.2)	0.072
Benzodiazepines, n(%)	13(1.5)	0(0)	13(2.2)	0.036	8(1.2)	5(3.1)	0.069
Traditional Chinese medicine, n(%)	14(1.6)	6(2.3)	8(1.3)	0.462	12(1.7)	2(1.2)	0.660
rTMS, n(%)	270(31.6)	108(41.7)	162(27.2)	< 0.001	240(34.6)	30(18.6)	< 0.001
MECT, n(%)	32(3.7)	15(5.8)	17(2.9)	0.038	26(3.8)	6(3.7)	0.988
Cognitive impairment and dementia							
AchEIs, n(%)	716(83.9)	232(89.6)	484(81.3)	0.003	613(88.5)	103(64.0)	< 0.001
Memantine, n(%)	456(53.4)	155(59.9)	301(50.6)	0.013	394(56.9)	62(38.5)	< 0.001
Ginkgo biloba extract, n(%)	376(44.3)	140(54.1)	236(39.7)	< 0.001	316(45.6)	60(37.3)	0.055
Citicoline, n(%)	360(42.2)	116(44.8)	244(41.0)	0.304	306(44.2)	54(33.5)	0.014
Chinese patent medicine, n(%)	181(21.2)	68(26.2)	113(19.0)	0.017	155(22.4)	26(16.2)	0.082
Psychosis							
quetiapine, n(%)	456(53.4)	195(75.3)	261(43.9)	< 0.001	397(57.3)	59(36.7)	< 0.001
Olanzapine, n(%)	417(48.8)	102(39.4)	305(51.3)	0.001	334(48.2)	73(45.3)	0.514
Clozapine, n(%)	295(34.5)	145(56.0)	150(25.2)	< 0.001	273(39.4)	22(13.7)	< 0.001
aripiprazole, n(%)	49(5.7)	16(6.2)	33(5.6)	0.715	49(7.1)	9(5.6)	0.929
Risperidone, n(%)	172(20.1)	54(20.9)	118(19.8)	0.733	149(21.5)	23(14.3)	0.04

Abbreviations: SNRI, serotonin-norepinephrine reuptake inhibitors; SSRIs, selective serotonin reuptake inhibitors; NaSSAs, noradrenergic and specific serotonergic sntidepressants; rTMS, repetitive transcranial magnetic stimulation; MECT, modified electroconvulsive therapy; AchEIs, acetylcholinesterase inhibitors

brain stimulation for treating PD, rTMS carries fewer risks and side effects, while strong evidence supports its effectiveness in reducing depression associated with the condition [12]. Movement disorder specialists and guideline-informed neurologists were more likely to select rTMS for managing PD-related depression (41.7% vs. 27.3%, $p < 0.001$, and 34.6% vs. 18.6%, $p < 0.001$). Although 80.91% of the composite neurologist population recommended psychological therapy, most believed that fewer than 10% of patients would actually receive it.

Cognitive Impairment/Dementia: In PD cognitive impairment management, acetylcholinesterase inhibitors (AchEIs) were prescribed by 83.8% of neurologists overall. Movement disorder specialists (89.6%) and guideline-informed neurologists (88.5%) demonstrated significantly higher AchEIs adoption ($p < 0.01$ and $p < 0.001$). Memantine utilization followed a similar pattern: 53.4% overall, rising to 59.9% and 56.9% in specialized groups ($p < 0.05$ and $p < 0.001$) (Table 3). Overall, 21.19% of the composite neurologist population chose Chinese patent medicine treatment, with movement disorder specialists showing a higher proportion of Chinese patent medicine usage compared to general neurologists (26.3% vs. 19.0%, $p < 0.05$).

Psychotic symptoms In managing PD-related psychotic symptoms, 70.6% of the composite neurologist population initially preferred PD medication adjustment. Movement disorder specialists (88.8%) and guideline-informed neurologists (81.3%) significantly outperformed general and uninformed neurologists in this approach (62.7% and 43.5%, respectively; $p < 0.0001$). Only 15.3% of the composite neurologist population demonstrated a thorough understanding of the psychiatric side effects of these medications. Notably, olanzapine, which can exacerbate parkinsonism, had a high utilization rate (47.7%) for psychotic symptoms in PD (Table 3). Compared to general and uninformed neurologists, movement disorder specialists and guideline-informed neurologists were more likely to favor quetiapine and clozapine for the management of psychotic symptoms in PD patients ($p < 0.001$) (Table 3).

In China, PD patients with comorbid depression, anxiety, or psychotic symptoms are typically referred to psychiatric clinics. Therefore, we also investigated psychiatric specialists' awareness and therapeutic approaches to NMS in PD. Psychiatrists tended to use selective serotonin reuptake inhibitors, olanzapine, psychological therapy, rTMS, and modified electroconvulsive therapy

Table 4 The treatment of psychiatric symptoms in patients with Parkinson's disease by the composite neurologist population and psychiatrists

Items	Specialty			Specialty		
	Neurologist	Psychiatrists	*p* value	Movement disorder specialist	Psychiatrists	*p* value
	(*n* = 854)	(*n* = 59)		(*n* = 259)	(*n* = 59)	
Depression/anxiety						
Dopamine agonists, n(%)	283(33.1)	4(6.8)	< 0.001	124(47.9)	4(6.8)	< 0.001
SNRIs, n(%)	123(14.4)	9(15.3)	0.094	38(14.7)	9(15.3)	0.909
SSRIs, n(%)	326(38.2)	34(57.6)	< 0.001	75(29.0)	34(57.6)	< 0.001
NaSSAs, n(%)	31(3.6)	0(0)	0.328	9(3.5)	0	0.146
Benzodiazepines, n(%)	13(1.5)	2(3.4)	0.397	0	2(3.4)	0.003
Chinese patent medicine, n(%)	14(1.6)	2(3.4)	0.286	6(2.3)	2(3.4)	0.635
rTMS, n(%)	270(31.6)	26(44.1)	0.048	108(41.7)	26(44.1)	0.739
MECT, n(%)	32(3.8)	6(10.2)	0.017	15(5.8)	6(10.2)	0.222
PD psychosis						
quetiapine, n(%)	456(53.4)	33(56.0)	0.706	195(75.3)	33(56.0)	0.003
Olanzapine, n(%)	407(47.7)	31(52.6)	0.468	102(39.4)	31(52.5)	0.064
Clozapine, n(%)	295(34.5)	15(25.4)	0.153	145(56.0)	15(25.4)	< 0.001
aripiprazole, n(%)	49(5.7)	18(30.5)	< 0.001	16(6.2)	18(30.5)	< 0.001
Risperidone, n(%)	172(20.1)	13(22.0)	0.726	54(20.9)	13(22.0)	0.84

Abbreviations: SNRI, serotonin-norepinephrine reuptake inhibitors; SSRIs, selective serotonin reuptake inhibitors; NaSSAs, noradrenergic and specific serotonergic sntidepressants; rTMS, repetitive transcranial magnetic stimulation; MECT, modified electroconvulsive therapy; AchEIs, acetylcholinesterase inhibitors

(Table 4). However, they were less likely to prescribe DAs, quetiapine, or clozapine ($p < 0.05$) (Table 4).

The treatment options for additional NMS can be found in Supplementary Table S3.

Multidisciplinary diagnosis and treatment

A multidisciplinary team for PD was available in 48.8% of the hospitals employing neurologists. Additionally, 45.8% of the composite neurologist population reported referring PD patients to other departments for managing NMS. However, a significant 69.4% were unfamiliar with social services related to PD.

Discussion

The primary objective of this study was to assess the perceptions and approaches to managing NMS in PD among neurology and psychiatry healthcare professionals across China. With PD cases on the rise, particularly in China, understanding current management strategies and identifying treatment disparities across specialties is critical for optimizing patient care and improving outcomes.

Our findings reveal that while there is an increased recognition of the impact of NMS on PD patients' QoL, significant gaps remain in their identification, early recognition, and management. These gaps could serve as guidance for future reforms in this field, with the aim of improving the overall care of PD patients on a local and national level.

A significant proportion (86.9%) of neurologists in our study were based in tertiary care hospitals, underscoring the representativeness of this survey in large public hospital settings. However, we identified several deficiencies in recognizing and managing NMS among healthcare professionals. These deficiencies include insufficient attention to NMS, under-utilization of standardized assessment tools, sub-optimal pharmacological treatments, limited-use of non-pharmacological interventions, limited promotion of the multidisciplinary approach of PD patients, and a lack of social support services related to PD. Similar deficiencies have been documented in other studies, including one from southwest China, which revealed a significant lack of awareness about NMS among neurologists in grassroots hospitals. In that study, none of the participants accurately identified the PD-related NMS. Additionally, more than half of the participants were uncertain about the appropriate medication for treating PD psychotic symptoms, with olanzapine being the most commonly used drug [13]. Another study analyzing national health insurance data highlighted the use of potentially inappropriate medications in elderly PD patients. For instance, 7.5% of PD patients were treated with olanzapine or risperidone for PD psychotic symptoms [14]. Internationally, survey studies from Sweden also identified poor adherence to pharmacological guidelines for PD [15, 16]. The root of these deficiencies appears to be an insufficient understanding of NMS among general neurologists. In tertiary hospitals, the growing sub-specialization within neurology departments may limit the scope of general neurologists' knowledge about PD. Encouragingly, our study shows that movement disorder specialists are more likely to effectively manage NMS, a finding consistent with prior research [17]. National guidelines have been shown to help standardize clinical practice; thus, promoting the

specialization of movement disorders within neurology departments and expanding the number of trained specialists should be a priority. Additionally, fostering widespread familiarity with PD guidelines across the broader neurology community is essential to improving NMS management [18].

It is important to highlight that certain NMS of PD may be triggered or worsened by medications prescribed for motor symptom management. Consequently, a thorough assessment of these symptoms is essential in the comprehensive care of PD. For example, DAs can trigger and exacerbate impulse control disorders (ICDs), while benztropine may worsen cognitive deficits. Our survey indicates that about 40% of neurologists occasionally or never monitor ICDs. Thus, a comprehensive evaluation of PD patients' NMS is vital in guiding appropriate medication choices. Furthermore, ongoing assessments should be conducted after treatment initiation to ensure optimal patient outcomes. This reinforces the critical need to emphasize NMS in PD management, as findings suggest that such manageable or even preventable complications warrant increased vigilance and attention.

Depression, anxiety, and psychotic symptoms are among the most impactful NMS, significantly affecting both the prognosis and QoL of PD patients. Our survey identified several areas in need of improvement, including delayed attention to these symptoms and inappropriate treatment choices, particularly for psychotic symptoms. In China, there is a concerning trend of low identification, treatment, and efficacy rates for these conditions. Many severe cases are referred to psychiatric outpatient clinics, where psychiatrists, despite being skilled in managing mood and psychotic symptoms, often lack specific knowledge about PD particularities. This gap in knowledge can result in sub-optimal outcomes. For example, our findings show that psychiatrists often prescribed olanzapine to treat psychotic symptoms, which can worsen the motor symptoms of PD. This highlights the need for enhanced training and collaboration between neurology and psychiatry to improve NMS management in PD.

Our study shows that reading clinical guidelines had a strong positive effect on physician practice. This finding emphasizes the need for additional physician training. It also highlights the importance of creating educational opportunities for treating physicians, especially for those managing a high volume of PD patients. Targeted education initiatives could further support physicians in optimizing PD patients' care and improving treatment outcomes.

Our study has some limitations. Firstly, we only surveyed healthcare professionals in tertiary hospitals, which may not accurately represent practices in secondary or community healthcare settings. Tertiary hospitals typically have more specialized resources and advanced training, potentially overstating the quality of NMS management in PD. The practices and capabilities in smaller or less resourced hospitals could differ significantly from those in specialized centers. Secondly, our research lacked patient-reported data, a critical gap in understanding the real-world aspects of PD. Patients' perspectives are essential for evaluating the actual impact and effectiveness of NMS management. Future research should prioritize capturing patient experiences through qualitative interviews or surveys, providing a more comprehensive view of NMS care. By including patient insights, we can better understand the alignment between clinical practices and patient needs, ultimately guiding more patient-centered interventions and improving overall care quality. Thirdly, a substantial proportion of participating physicians (approximately half) do not regularly treat PD patients. This sampling characteristic may raise questions about potential biases in knowledge assessment. However, our survey reflects the real-world clinical landscape in China, where PD management primarily involves general neurologists across diverse settings. The study reveals significant knowledge variations between movement disorder specialists and general neurologists, highlighting critical practice gaps and educational needs. While this diversity may introduce some variability, it also provides valuable insights into the current state of PD care and underscores the necessity of targeted interventions and comprehensive training programs. Fourthly, our study did not address potential sex-related variations in PD manifestations or differential clinical management strategies [19]. Additionally, we did not examine clinicians' understanding of the fluctuating nature of NMS in PD, which can also affect treatment options [20]. Lastly, we did not investigate whether clinicians perform necessary differential diagnostics when identifying NMS in PD patients, including ruling out alternative etiologies and providing timely, appropriate referrals. This aspect is crucial in PD management, as clinicians must recognize that patients may have concurrent conditions or diseases that could potentially mimic or be misdiagnosed as NMS unrelated to PD. Future research should address these limitations.

Conclusion

This study undermines the importance of evaluation and treatment of NMS in PD to enhance symptom management and QoL for patients in China. Despite growing recognition of the detrimental impact of NMS, significant gaps in care persist, highlighting areas where targeted efforts are needed. Our findings point towards the need for enhanced NMS screening, even from early stages of PD, and the subsequent optimization of pharmacological and non-pharmacological interventions, aligning with

well-established guidelines and recommendations. With the necessary knowledge and expertise, clinicians should be able to timely and accurately detect NMS in PD, and implement appropriate interventions to mitigate their impact effectively.

Abbreviations

PD	Parkinson's disease
NMS	Non-motor symptoms
QoL	Quality of life
Das	Dopamine receptor agonists
ICDs	Impulse control disorders
rTMS	Repetitive transcranial magnetic stimulation
AchEIs	Dopamine receptor agonists

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12883-025-04175-8.

Supplementary Material 1

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Author contributions
Conception and design: Jing Chen, Xiaotong Feng, Danhua Zhao, Lin Zhang and Junliang Yuan. Administrative support: Junliang Yuan, Baoyu Chen. Collection and assembly of data: Jing Chen, Xiaotong Feng, Danhua Zhao, Baoyu Chen, Qi Wang, Yuan Li, Chaobo Bai, Junyi Chen, Xintong Guo, Jinjin Wang. Data analysis and interpretation: Jing Chen, Fengxiaotong, Baoyu Chen. Manuscript writing: All authors. Final approval of manuscript: All authors. The final version has been revised by: Junliang Yuan, Lin Zhang, Jing Chen, and Chaobo Bai.

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Data availability
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Research Ethics Committee of Peking University Sixth Hospital (2023-38), and written informed consent was obtained from all participants. The research adhered to the principles outlined in the Helsinki Declaration and was conducted by approved guidelines.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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