Clinical features and relative factors of constipation in a cohort of Chinese patients with Parkinson's disease

Bai-Hua Sun, Tao Wang, Nian-Ying Li, Qiong Wu, Jin Qiao

ORCID number: Bai-Hua Sun 0000-0002-6514-3702; Tao Wang 0000-0002-8292-5300; Nian-Ying Li 0000-0002-9844-5336; Qiong Wu 0000-0003-1803-579X; Jin Qiao 0000-0002-7344-9461.

Author contributions: Qiao J and Wu Q designed, organized, and supervised the study and revised the manuscript; Sun BH, Wang T, and Li NY completed the data collection; Sun BH performed the statistical analysis and article writing.

Supported by Key Research and Development Program of Shaanxi Province, China, No. 2018SF-016 and No. 2020SF-153.

Institutional review board statement: The study was reviewed and approved by the ethics committee of the First Affiliated Hospital of Xi'an Jiaotong University (No. XJTU1AF2019LSK-037 and No. XJTU1AF2020LSK-182).

Conflict-of-interest statement: The authors have no potential conflicts of interest to disclose.

Open-Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in

Abstract

BACKGROUND
Constipation as a most common non-motor symptom of Parkinson's disease (PD), has a higher prevalence compared to the general population. The etiologies of constipation in PD are diverse. In addition to physical weakness and other factors of disease, the lifestyles and eating habits are also important factors. Therefore, the prevalence and influencing factors of constipation may vary among different populations.

AIM
To determine the prevalence of constipation and analyze relative factors in a cohort of Chinese patients with PD.

METHODS
All the patients diagnosed with PD according to the movement disorders society criteria were consecutively collected by a self-developed questionnaire. Rome III diagnostic criteria were used to assess functional constipation and Wexner score was used to estimate the severity of constipation. Non-motor symptoms (NMS) were assessed with the non-motor symptoms assessment scale (NMSS). Unified Parkinson's disease Rating Scale III (UPDRS III) was used to evaluate the severity of motor symptoms. The modified Hoehn-Yahr stage was used to evaluate the severity of PD. Cognitive function was assessed using Montreal cognitive
Parkinson’s disease; Non-motor symptoms; Constipation; Clinical characteristics; Quality of life; Depression

**Key Words:** Parkinson’s disease; Non-motor symptoms; Constipation; Clinical characteristics; Quality of life; Depression

**Core Tip:** This study aimed to determine the prevalence of constipation and analyze its clinical characteristics and relative risk factors in a cohort of Chinese patients with Parkinson’s disease (PD). Our findings confirmed that constipation had a relatively high frequency in patients with PD. The patients with constipation had a higher incidence of depression, which led to worse quality of life.

**Citation:** Sun BH, Wang T, Li NY, Wu Q, Qiao J. Clinical features and relative factors of constipation in a cohort of Chinese patients with Parkinson’s disease. *World J Gastrointest Pharmacol Ther* 2021; 12(1): 21-31

**URL:** https://www.wjgnet.com/2150-5349/full/v12/i1/21.htm

**DOI:** https://dx.doi.org/10.4292/wjgpt.v12.i1.21

---

**INTRODUCTION**

Parkinson’s disease (PD) is a degenerative disease of the central nervous system. In addition to motor symptoms such as resting tremor, bradykinesia, myotonia, and posture imbalance, non-motor symptoms (NMS) are also very common: Olfactory dysfunction, autonomic dysfunction, mood disorders, sleep disorders, gastrointestinal symptoms, cognitive impairment, etc. NMS can occur at any stage of the disease, and some even appear before the onset of motor symptoms and seriously affect quality of life, especially in later stages. In recent years, it has been considered that the brain-intestinal-microbial axis plays a significant role in pathogenesis or progression of PD. The intestinal nervous system may be the onset site of PD. Gastrointestinal symptoms may be correlated to the occurrence and deterioration of PD. The factors causing constipation are complex. It is not only physical weakness but also lifestyle risks such as less fluid intake. Additionally, side effects of medications are responsible for many patients. More and more evidence showed that delayed colonic transit and...
peripheral parasympathetic system dysregulation are very important mechanisms\textsuperscript{3,7}. The lifestyles and eating habits are also important factors. Different races and regions have different lifestyles and eating habits. In addition, studying on the gastrointestinal symptoms in PD can be conducive to understanding the pathogenesis and heterogeneity of clinical manifestations of PD. In the present study, we comprehensively screened NMS, especially constipation, in patients with PD in northwestern China and analyzed the clinical characteristics and relative factors of constipation.

**MATERIALS AND METHODS**

**Patients**

Based on a cross-sectional survey, consecutive patients who met the movement disorders society criteria for PD\textsuperscript{8} were recruited at the First Affiliated Hospital of Xi’an Jiaotong University (Shaanxi Province, China) from March to November 2018. The secondary Parkinson’s syndrome such as post-traumatic, drug-induced, and vascular parkinsonism were excluded. Patients who could not complete rating scales due to severe cognitive dysfunction and those with acute and chronic gastrointestinal diseases in the past 6 mo were excluded. The research was approved by the local ethics committee. All patients gave their consent to participate and were assessed by experienced neurologists by face-to-face interviews.

**Clinical assessments**

Demographic variables, such as gender, age, side of onset, education level, disease duration, medical history, motor complications, and equivalent daily dose of levodopa were recorded for all patients using a self-designed questionnaire.

Constipation was assessed based on Roman III criteria for functional constipation. The constipation severity was evaluated by Wexner score (The lowest score is 0, and the highest score is 30. The higher the score, the more severity of constipation).

The modified Hoehn-Yahr stage was used to assess severity and Unified Parkinson’s disease Rating Scale (UPDRS) III was used to assess motor symptoms.

NMS were evaluated with the non-motor symptoms assessment scales (NMSS), a self-administered 30-item instrument for screening the presence NMS and incidence of each non-motor symptom. The higher the scores, the more severe the NMS.

Depression was assessed using the Hamilton depression scale (HAMD)-24 items. A score of HAMD scale-24 items ≥ 8 points suggested depression.

Anxiety was assessed using the Hamilton anxiety scale (HAMA)-14 items. A score of HAMD scale-14 items ≥ 7 points indicated anxiety.

Quality of life was assessed using the Parkinson’s disease Questionnaire-39 (PDQ-39). The higher the score, the worse the quality of life.

Cognitive impairment was evaluated using the Montreal cognitive assessment (MoCA) (if educational years < 12 years, 1 point was added to the test results to correct the test bias, and < 26 points suggested cognitive dysfunction).

The tremor score was composed of item 16 in UPDRS II and items 20 and 21 in UPDRS III, and non-tremor scores included items 5, 7, and 12 to 15 in UPDRS II and items 18 to 19 and 22 to 31 in UPDRS III. The motor symptoms have two clinical subtypes: Tremor type (tremor score/non-tremor score > 1) and non-tremor type (straight-type, tremor score/non-tremor score ≤ 1).

**Data analysis**

Data were analyzed using SPSS version 17.0 (SPSS Inc., Chicago, IL, United States). The Normally distributed continuous data are represented by the mean ± standard deviation (SD), and non-normally distributed data are presented by medians (quartile) and were analyzed by the Kruskal-Wallis test. Discrete variables were compared by the Chi square test. The t-test was used to compare the age, age of onset, UPDRS III, levodopa equivalent dose, NMSS, HAMA, HAMD, MoCA, PDQ-39, and Wexner scores between the constipation and non-constipation groups. The Kruskal-Wallis test was used to compare the incidence of constipation and one-way ANOVA was used to compare Wexner scores among different Hoehn-Yahr stages.

Pearson correlation analysis was performed to examine the correlation of constipation with sex, age, age of onset, scores of NMS, UPDRS total, UPDRS, PDQ-39, MoCA, HAMD, and HAMA, and Hoehn-Yahr stage. The unconditional logistic regression model was conducted to identify the risk factors for constipation in PD patients. A $P$ value less than 0.05 was considered statistically significant.
RESULTS

Patient characteristics
A total of 166 subjects with PD were enrolled, including 76 women and 90 men, with a mean age of 65.92 ± 9.02 years, mean disease duration of 4.89 ± 3.93 years, and mean age at onset of 61.01 ± 9.97 years. Table 1 shows their characteristics and scores of rating scales. According to modified Hoehn-Yahr stage, 21 (12.65%) patients were in stage 1, 31 (18.67%) in stage 1.5, 56 (33.73%) in stage 2, 20 (12.05%) in stage 2.5, 28 (16.87%) in stage 3, and 10 (6.02%) in stage 4. Among them, 134 (80.72%) patients were treated with levodopa, 92 (55.42%) with dopamine agonists, 44 (26.51%) with monoamine oxidase B inhibitor, 9 (5.42%) with catechol-oxyl-methyltransferase inhibitor, 26 (15.66%) with anticholinergic drug, and 15 (9.04%) with amantadine.

Comparison of general characteristics between patients with constipation and non-constipation
Of all patients with PD enrolled, 87 (52.41%) were accompanied with constipation. Among constipation patients, 30 (34.48%) had constipation occurring before 6.30 ± 5.06 years at onset of motor symptoms. The age of patients, disease duration, Hoehn-Yahr grade, duration of levodopa treatment, incidence of motor complications, scores of UPDRS total and UPDRS III, NMSS, HAMD, HAMA, and PDQ-39 in the constipation group were significantly higher than those in the non-constipation group (P < 0.05), but there was no statistical difference in the scores of MoCA, clinical types, or medications between the two groups (P > 0.05). Details are given in Table 2.

Incidence of depression, anxiety, and cognitive impairment between patients with and without constipation
Compared to the non-constipation group, there was a higher incidence of depression in patients with constipation (46.84% vs 64.37%, P < 0.05). But there was no statistical difference in the incidence of anxiety and cognitive impairment between the two groups (P > 0.05). Detailed data are shown in Table 3.

Incidence and severity of constipation in patients of different Hoehn-Yahr stages
According to the modified Hoehn-Yahr stage, there were 52 patients in stage 1-1.5, 76 in stage 2-2.5, 28 in stage 3, and 10 in stage 4. Although the incidence of constipation did not increase while Hoehn-Yahr stage increased (P > 0.05), the severity of constipation increased while Hoehn-Yahr stage increased (P < 0.05). Detailed results are shown in Table 4.

Risk factors for constipation
Pearson correlation analysis showed that constipation was moderately positively correlated with age, Hoehn-Yahr stage, NMSS scores, UPDRS III and total scores, PDQ-39 scores, MoCA scores, HAMD scores, and HAMA scores (r = 0.255, 0.172, 0.361, 0.194, 0.221, 0.237, 0.238, and 0.207, respectively, P < 0.05). Results are shown in Table 5. Other variables such as sex, age at onset, MoCA scores, and medication did not have a correlation with constipation (P > 0.05).

Using constipation as the dependent variable, and factors such as age, disease duration, Hohen-Yahr stages, UPDRS III scores, duration of medication, depression and anxiety, and NMSS score as independent variables, the logistic regression analysis demonstrated that only NMSS score was an independent risk factor for constipation (P < 0.001).

DISCUSSION
Traditionally, cytotoxicity and Lewy body (LB) formation mediated by α-synuclein (α-SYN) was preferential in the pathogenesis of PD. In fact, the pathological changes of PD are extensive. Besides the brainstem, abnormal α-SYN also deposits in many other parts of the body including the intestine, pancreas, heart, salivary glands, and skin. PD is a syndrome of multiple organ dysfunction involving dopaminergic, adrenergic, serotonergic, and cholinergic pathways. Therefore, the clinical manifestations of PD include varieties of NMS such as olfactory hypothyroidism, cognitive disorders, sleep disorders, depression, constipation, and other motor symptoms. We have realized the negative impact of NMS on quality of life. For some PD patients, disability may be more severe in NMS than dyskinesia. Although PD has been recognized for 200
Table 1 Clinical characteristics of the subjects

| Characteristic                      | Value       | Characteristic                      | Value       |
|------------------------------------|-------------|------------------------------------|-------------|
| Patients n                         | 166         | Hoehn-Yahr stage n (%)             |             |
| Male n (%)                         | 90 (54.22)  | Stage 1                            | 21 (12.7)   |
| Mean age ± SD (yr)                 | 65.92 ± 9.02| Stage 1.5                          | 31 (18.7)   |
| Hypertension n (%)                 | 60 (36.14)  | Stage 2                            | 56 (33.7)   |
| Diabetes n (%)                     | 14 (8.43)   | Stage 2.5                          | 20 (12.0)   |
| Coronary heart disease n (%)       | 16 (9.64)   | Stage 3                            | 28 (16.9)   |
| Family history of PD n (%)         | 8 (4.82)    | Stage 4                            | 10 (6.0)    |
| Mean age at onset ± SD (yr)        | 61.01 ± 9.97| Mean scores of scale ± SD         |             |
| Disease duration (yr)              | 4.89 ± 3.93 | UPDRS total                        | 39.16 ± 18.39|
| Clinical type n (%)                |             | UPDRS III                          | 21.79 ± 11.72|
| Tremor                             | 91 (54.82)  | Wexner                             | 4.29 ± 5.30 |
| Non-tremor                         | 75 (45.18)  | HAMD                               | 10.00 ± 8.61|
| Motor complications n (%)          |             | HAMA                               | 11.18 ± 10.27|
| Symptom fluctuation                | 51 (30.72)  | MoCA                               | 19.56 ± 5.75|
| Dyskinesia                         | 25 (15.06)  | PDQ-39                             | 35.66 ± 24.06|
| Medication n (%)                   |             | NMSS                               | 49.89 ± 32.55|
| Levodopa                           | 134 (80.72) |                                     |             |
| Dopamine agonist                   | 92 (55.42)  |                                     |             |
| MAO-B inhibitor                    | 44 (26.51)  |                                     |             |
| COMT inhibitor                     | 9 (5.42)    |                                     |             |
| Anticholinergic                    | 26 (15.66)  |                                     |             |
| Amantadine                         | 15 (9.04)   |                                     |             |

PD: Parkinson’s disease; UPDRS: Unified Parkinson’s disease Rating Scale; HAMD: Hamilton depression scale; HAMA: Hamilton anxiety scale; MAO: Monoamine oxidase; COMT: Catechol-o-methyltransferase; NMSS: Non-motor symptoms assessment scales; PDQ-39: Parkinson’s disease questionnaire-39; MoCA: Montreal cognitive assessment.

years, the mechanisms of its pathogenesis and treatments still need to be explored, especially outside the central nervous system\(^1\). The present research showed that NMS are common during the whole course of PD. Almost all PD patients complained of at least one NMS, with an average of eight NMS\(^1\). NMS may involve multiple regions and neurotransmitter disorder in the pathogenesis of PD\(^1\). A Korean population study showed that gastrointestinal symptoms were widespread even in patients with early PD without treatment, with the incidence of constipation being 46.3%\(^2\). Some studies have shown that before the midbrain dopaminergic neurons were affected, a variety of NMS could occur, which was associated with a higher risk of developing PD. It was suggested that NMS may be considered an early clinic manifestation in PD patients\(^2\). Therefore, constipation, one of NMS, in PD patients may be an intrinsic symptom.

Our findings confirm that constipation (52.41%) is a common NMS in PD with a relatively high frequency. Constipation had occurred in about 34.48% of patients for a mean of 6.3 years before the onset of motor symptoms. The incidence of constipation in patients with PD has been reported to be 4%-71%, mostly at 24%-63%, some even up to 80%\(^2\). The reason for the inconsistencies in epidemiological surveys may be related to differences in study population and inclusion criteria. A prospective clinical study found that people who had defecated more than once a day had a 2.7 times risk of developing PD after 10 years of follow-up than those who defecated less than once a day\(^3\). Pathological studies also demonstrated that patients defecated more than once a day had a four-fold increase in the probability of subsequent Lewy body deposition compared with those who defecated less than once a day\(^4\). These findings suggested
Table 2 Comparison of general characteristics between the constipation and non-constipation groups

|                          | Constipation | Non-constipation | t or χ² value | P value |
|--------------------------|--------------|------------------|--------------|---------|
| Male, n (%)              | 52 (59.77)   | 38 (48.10)       | 2.271        | 0.132   |
| Mean age ± SD (yr)       | 68.10 ± 8.16 | 63.51 ± 9.42     | 3.355        | 0.001   |
| Mean age at onset ± SD (yr) | 62.34 ± 9.38 | 59.56 ± 10.52    | 1.796        | 0.074   |
| Mean disease duration ± SD (yr) | 5.66 ± 4.41 | 4.00 ± 3.12      | 2.732        | 0.007   |
| Clinical types, n (%)    |              |                  |              |         |
| Tremor                   | 46 (52.87)   | 45 (56.96)       |              |         |
| Non-tremor               | 41 (47.13)   | 34 (43.04)       | 0.279        | 0.597   |
| Hoehn-Yahr stage (median, quartile) | 2.0 (1.5, 3.0) | 2.0 (1.5, 2.5)   | -2.451       | 0.014   |
| Mean UPDRS total scores ± SD | 43.02 ± 19.57 | 34.90 ± 16.05    | 2.389        | 0.004   |
| Mean UPDRS III scores ± SD | 19.41 ± 10.97 | 19.11 ± 10.79    | 2.512        | 0.013   |
| Mean levodopa equivalent dose ± SD (mg/d) | 468.17 ± 357.98 | 441.92 ± 428.78  | 0.416        | 0.678   |
| Mean daily dose of levodopa ± SD (mg/d) | 500.41 ± 326.55 | 430.91 ± 163.93  | 1.491        | 0.138   |
| Mean levodopa medication times ± SD (mo) | 53.43 ± 49.56 | 29.25 ± 35.77    | 3.265        | 0.001   |
| Medication, n (%)        |              |                  |              |         |
| Levodopa                 | 73 (83.91)   | 61 (77.22)       | 1.192        | 0.275   |
| Dopamine agonist         | 53 (60.92)   | 39 (49.37)       | 2.273        | 0.135   |
| MAO-B inhibitor          | 23 (26.44)   | 21 (26.58)       | < 0.001      | 0.983   |
| COMT inhibitor           | 7 (8.05)     | 2 (2.53)         | 2.435        | 0.117   |
| Anticholinergic          | 14 (16.09)   | 12 (15.19)       | 0.026        | 0.873   |
| Amantadine               | 7 (8.05)     | 8 (10.13)        | 0.218        | 0.641   |
| Motor complications, n (%) |            |                  |              |         |
| Symptom fluctuation      | 33 (57.93)   | 18 (22.78)       | 4.463        | 0.035   |
| Dyskinesia               | 18 (20.69)   | 7 (8.86)         | 4.529        | 0.033   |
| NMSS scores              | 61.05 ± 32.95| 37.59 ± 27.42    | 4.928        | 0.000   |
| HAMD scores              | 11.94 ± 8.59 | 7.86 ± 8.16      | 3.113        | 0.002   |
| HAMA scores              | 13.20 ± 10.37| 8.96 ± 9.75      | 2.688        | 0.088   |
| MoCA scores              | 19.71 ± 5.48 | 19.36 ± 6.11     | 0.374        | 0.709   |
| PDQ-39 scores            | 41.07 ± 25.58| 29.69 ± 20.84    | 3.104        | 0.002   |

UPDRS: Unified Parkinson’s disease Rating Scale; MAO: Monoamine oxidase; COMT: Catechol-o-methyltransferase; NMSS: Non-motor symptoms assessment Scales; HAMD: Hamilton depression scale; HAMA: Hamilton anxiety scale; MoCA: Montreal cognitive assessment; PDQ-39: Parkinson’s disease questionnaire-39.

...that constipation may promote the risk of PD. Although constipation is universal in patients with PD, the clinical manifestations are diverse. Lifestyles especially food habits are responsible for constipation in PD patients, but not a critical factor. Constipation patients with PD consumed less water fluid and fewer fresh fruits, raw vegetables, fish, meats, etc.\[17\]. The incidence of constipation in PD patients is higher in Asian populations than in Western populations. According to surveys in Asian countries (such as in China, South Korea, and India), the difference may be related to diet habit, exercise, nutritional status, gut flora, education, and drug treatment\[18\].

Constipation in PD patients is directly related to its pathogenesis. According to the Braak staging scheme, the PD lesions do not start from the dopaminergic neurons in the midbrain. The olfactory bulb, the glossopharyngeal nerve, the vagus nerve dorsal...
Table 3 Incidence of depression, anxiety, and cognitive impairment between the constipation and non-constipation groups

|       | n  | Anxiety (%) | Depression (%) | Cognitive impairment (%) |
|-------|----|-------------|----------------|--------------------------|
| Constipation | 87 | 55 (63.22)  | 56 (64.37)      | 71 (81.61)               |
| Non-constipation | 79 | 40 (50.63)  | 37 (46.84)      | 63 (79.75)               |
| χ²    | 2.695 |            |                |                          |
| P     | 0.115 |            |                |                          |

Table 4 Comparison of incidence and severity of constipation in different modified Hoehn-Yahr grades (% ± s)

| Grade | 1-1.5 | 2-2.5 | 3 | 4 | χ²/F | P value |
|-------|-------|-------|---|---|------|---------|
| n     | 52    | 76    | 28 | 10 |      |         |
| Constipation | 22 (42.31) | 41 (53.95) | 16 (57.14) | 8 (80.00) | 5.470 | 0.140   |
| Wexner score | 6.73 ± 4.14 | 6.76 ± 3.58 | 11.19 ± 5.38 | 13.50 ± 2.98 | 10.138 | < 0.001 |

Table 5 Correlations of constipation and different related scale scores

|                  | r     | P value |
|------------------|-------|---------|
| Age              | 0.255 | 0.001   |
| Modified Hoehn-Yahr stage | 0.172 | 0.027   |
| NMMS scores      | 0.361 | < 0.001 |
| UPDRS III scores | 0.194 | 0.013   |
| UPDRS total scores | 0.221 | 0.004   |
| PDQ-39 scores    | 0.237 | 0.002   |
| HAMD scores      | 0.238 | 0.002   |
| HAMA scores      | 0.207 | 0.008   |

NMSS: Non-motor symptoms assessment scales; UPDRS: Unified Parkinson’s disease Rating Scale; PDQ-39: Parkinson’s disease questionnaire-39; HAMD: Hamilton depression scale; HAMA: Hamilton anxiety scale.

In the early stage of PD, the Lewy body has been found to be deposited in the submucosal plexus of the intestine[21]. It has been also reported that the incidence of PD in constipation patients was 3.3-4.2 times higher than those without constipation, and the severity of constipation was closely associated with the occurrence of PD[22]. We therefore postulated that constipation may be a precursor sign in the early stage of PD.

It has been found that there is a higher incidence of anxiety and depression in PD patients. The prevalence of depression varies from 2.7% to 90%, which may be attributed to differences of methodology or diagnostic criteria. A report indicated that the prevalence of depression was 11.17% and anxiety was 25.81% in Chinese PD patients[23]. Our findings show that the prevalence of depression and anxiety in PD patients was higher, and patients with constipation were more prone to depression but...
without anxiety and cognitive impairment. Hawkes et al. have proved that the pathogenesis of PD is not only associated with the substantia nigra, but also related to the raphe nucleus and locus coeruleus before the presence of motor symptoms in PD. It was suggested that serotonin and noradrenaline were involved in the occurrence of depression in PD.

Univariate analysis showed that the PD patients with constipation had older age, longer disease duration, more severe motor symptoms, and higher Hoehn-Yahr stages. The causes and mechanisms of constipation with PD are still unclear. The decline of sphincter function and anti-PD drugs such as levodopa and benzhexol are important factors. Other factors such as abdominal muscle weakness, decreased water intake, decreased activity, and bed rest also can increase the risk of constipation occurrence. In recent years, gut-first theory of PD exactly explained the causes of gastrointestinal symptoms. In addition to central nervous system degeneration, PD also undergoes degeneration of the enteric nerves, which is even earlier than that of the central nervous system. During the progression of PD, the changes of intestinal microbial flora could cause changes in the permeability of the intestinal mucosa and intestinal inflammation, which may result in the misfolding of α-SYN, and the misfolded α-SYN is deposited in neurons of intestinal mucosal and parasympathetic neurons of the spinal cord. Subsequently, dysfunction of intestinal neurons could cause delayed colonic transit and outlet obstruction, and finally resulted in constipation. In addition, the degeneration of the dorsal vagus nucleus in PD patients may lead to autonomic nervous dysfunction, exacerbation of gastrointestinal dysfunction, and failure of defecation-related muscle contraction and relaxation. Dysfunction of the pelvic floor and anorectal sphincter is another cause. The incidence of depression in patients with constipation is also increased. Depression may result in decreased ability of physical activity, daily activities, appetite, or gastrointestinal function, and cause constipation to develop and worsen as the disease progresses.

The current study has some limitations that should be pointed out. First, this is an observational, descriptive, survey study and our sample size is relatively modest. Moreover, the research subjects mainly from outpatients may lead to selective bias of the global PD population. Second, depression, anxiety, and cognition are only suggestibility of state due to the rating scale but not a formal clinical diagnosis. Finally, some variables such as adverse lifestyle and food habits of participants are not taken into account. Follow-up study about constipation in larger PD cohorts would provide accurate specific scales for different variables and a more comprehensive overview.

CONCLUSION
Our findings confirm that constipation has a relatively high frequency in patients with PD. PD patients with constipation have a higher incidence of depression, which leads to worse quality of life.

ARTICLE HIGHLIGHTS

Research background
Parkinson’s disease (PD) is a neurodegenerative disorder and causes motor symptoms including resting tremor, akinesia, and rigidity. Recently, the focus of clinical research
on PD is shifting to non-motor symptoms (NMS). Among all NMS, constipation is particularly common, but the reason why PD patients are prone to constipation is still unclear. In addition to physical weakness and other factors, lifestyles and eating habits are important factors as well. The prevalence and influencing factors of constipation may vary among different populations.

Research motivation
At present, the mechanisms and risk factors underlying constipation in patients with PD are still uncertain. Although the prevalence of constipation in Chinese patients with PD has been reported before, it may vary among different populations due to the different lifestyles and eating habits. Therefore, we need to understand the prevalence and influencing factors of constipation in the PD population in northwest China.

Research objectives
To investigate the prevalence and risk factors of constipation in a cohort study of Chinese patients with PD.

Research methods
Based on accepted diagnostic criteria and a series of clinic rating scales, which contained modified Hoehn-Yahr stage, Unified PD Rating Scale (UPDRS) III, non-motor symptoms assessment scale (NMSS), Hamilton depression scale (HAMD), Hamilton anxiety scale (HAMA), Parkinson’s disease Questionnaire-39 (PDQ-39), Montreal cognitive assessment, etc. The incidence and related factors of constipation was identified based on a retrospective survey. All subjects were recruited from March to November 2018 at the Department of Neurology of the First Affiliated Hospital of Xi’an Jiaotong University. In the following statistical analyses, t-test, spearman correlation, nonparametric test, one-way ANOVA, and unconditional logistic regression analysis were used.

Research results
In this study, 52.41% of patients were accompanied with constipation, and 34.48% had constipation occurring 6.30 ± 5.06 years before the onset of motor symptoms. The age of patients, disease duration, Hoehn-Yahr stage, duration of levodopa treatment, incidence of motor complications, scores of UPDRS total and UPDRS III, NMSS, HAMD, HAMA, and PDQ-39 in the constipation group were significantly higher than those in the non-constipation group (P < 0.05). Compared to the non-constipation group, there was a higher incidence of depression in patients with constipation (46.84% vs 64.37%, P < 0.05). The logistic regression analysis demonstrated that only NMSS score was an independent risk factor for constipation (P < 0.001).

Research conclusions
Our findings confirm that constipation has a relatively high frequency in patients with PD. PD patients with constipation have a higher incidence of depression, which leads to worse quality of life.

Research perspectives
Constipation is a common symptom in PD patients and reduces their quality of life. It should attract more attention in the future studies.

ACKNOWLEDGEMENTS
We thank all patients and their caregivers who agreed to take part in this study.

REFERENCES
1. Zhang TM, Yu SY, Guo P, Du Y, Hu Y, Piao YS, Zuo LJ, Lian TH, Wang RD, Yu QJ, Jin Z, Zhang W. Nonmotor symptoms in patients with Parkinson disease: A cross-sectional observational study. Medicine (Baltimore) 2016; 95: e5400 [PMID: 27977578 DOI: 10.1097/MD.0000000000005400]
2. Su A, Gandhy R, Barlow C, Triadafilopoulos G. A practical review of gastrointestinal manifestations in Parkinson's disease. Parkinsonism Relat Disord 2017; 39: 17-26 [PMID: 28258927 DOI: 10.1016/j.parkreldis.2017.02.029]
3. Fasano A, Visanji NP, Liu LW, Lang AE, Pfeiffer RF. Gastrointestinal dysfunction in Parkinson's
Sun BH et al. Constipation in Chinese patients with PD

disease. *Lancet Neurology* 2015; 14: 625-639 [PMID: 25987282 DOI: 10.1016/S1474-4422(15)00007-1]

4 Mulak A, Bonaz B. Brain-gut-microbiota axis in Parkinson's disease. *World Journal of Gastroenterology* 2015; 21: 10609-10620 [PMID: 26457021 DOI: 10.3748/wjg.v21.i37.10609]

5 Ueki A, Otsuka M. Life style risks of Parkinson's disease: association between decreased water intake and constipation. *J Neurology* 2004; 251 Suppl 7: v118-v123 [PMID: 15505750 DOI: 10.1007/s00415-004-1706-3]

6 Meek PD, Evang SD, Tadrous M, Roux-Lirange D, Triller DM, Gumustop B. Overactive bladder drugs and constipation: a meta-analysis of randomized, placebo-controlled trials. *Dig Dis Sci* 2011; 56: 7-18 [PMID: 20596778 DOI: 10.1007/s10620-010-1313-3]

7 Cersosimo MG, Benaroch EE. Pathological correlates of gastrointestinal dysfunction in Parkinson's disease. *Neurobiol Dis* 2012; 46: 559-564 [PMID: 22048068 DOI: 10.1016/j.nbd.2011.10.014]

8 Postuma RB, Berg D, Stern M, Poeke W, Olano CW, Oertel W, Obeso J, Marek K, Litvan I, Lang AE, Halliday G, Goetz CG, Gasser T, Dubsob B, Chan P, Bloem BR, Adler CD, Deuschl G. MDS clinical criteria for Parkinson's disease. *Mov Disord* 2015; 30: 1591-1601 [PMID: 26474316 DOI: 10.1002/mds.26424]

9 Titova N, Padmakumar C, Lewis SJG, Chaudhuri KR. Parkinson's: a syndrome rather than a disease? *J Neurological Transmissions* (Vienna) 2017; 124: 907-914 [PMID: 28028643 DOI: 10.1002/jn.2-1667-6]

10 Kadastik-Eerme L, Rosenthal M, Paju T, Muldmaa M, Taba P. Health-related quality of life in Parkinson's disease: a cross-sectional study focusing on non-motor symptoms. *Health Quality of Life Outcomes* 2015; 13: 83 [PMID: 26882801 DOI: 10.1186/s12955-015-0281-x]

11 Przedborski S. The two-century journey of Parkinson disease research. *Nat Rev Neurosci* 2017; 18: 251-259 [PMID: 28303016 DOI: 10.1038/nr.2017.25]

12 Kim HS, Cheon SM, Seo JW, Ryu HJ, Park KW, Kim JW. Nonmotor symptoms more closely related to Parkinson's disease: comparison with normal elderly. *J Neurosci* 2013; 33: 72-73 [PMID: 23102851 DOI: 10.1016/j.jns.2012.10.004]

13 Sung HY, Park JW, Kim JS. The frequency and severity of gastrointestinal symptoms in patients with early Parkinson's disease. *J Mov Disorders* 2014; 7: 7-12 [PMID: 24926404 DOI: 10.14802/jmd.14006]

14 Chen H, Zhao EJ, Zhang W, Lu Y, Liu R, Huang X, Ciesielski-Jones AJ, Justice MA, Cousins DS, Peddada S. Meta-analyses on prevalence of selected Parkinson's nonmotor symptoms before and after diagnosis. *Transl Neurodegener* 2015; 4: 1 [PMID: 25671103 DOI: 10.1186/2047-9158-4-1]

15 Stirpe P, Hoffmann M, Badiali D, Colosimo C. Constipation: an emerging risk factor for Parkinson's disease? *Eur J Neurology* 2016; 23: 1606-1613 [PMID: 27444575 DOI: 10.1111/ejn.13082]

16 Abbott RD, Petrovitch H, White LR, Masaki KH, Tanner CM, Curb JD, Launer LJ, Kukull WA, Kritchevsky SB, Colombo RJ, Ross GW, Petrovitch H, Tanner CM, Davis DG, Masaki KH, Launer LJ, Curb JD, White LR. Bowel movement frequency in late-life and incidental Lewy bodies. *Mov Disord* 2007; 22: 1581-1586 [PMID: 17523915 DOI: 10.1002/mds.21560]

17 Cassani E, Barichella M, Ferri V, Pinelli G, Iorio L, Bolli C, Caronni S, Faierman SA, Mottollea A, Husani C, Monajemi F, Pasqua M, Lubisco A, Cereda E, Frazzitta G, Petroni ML, Pezzoli G. Dietary habits in Parkinson's disease: Adherence to Mediterranean diet. *Parkinsonism Relat Disorders* 2017; 42: 40-46 [PMID: 28647435 DOI: 10.1016/j.parkreldis.2017.06.067]

18 Sauерbier A, Jikritsadasuk O, Titova N, Klingshoefer L, Tsouyi Y, Carr H, Kumar H, Banerjee R, Erro R, Bhadayasris A, Schrag A, Zis P, Lim SY, Al-Hashel JY, Kamei WA, Martinez-Martin P, Ray Chaudhuri K. Non-Motor Symptoms Assessed by Non-Motor Symptoms Questionnaire and Non-Motor Symptoms Scale in Parkinson's Disease in Selected Asian Populations. *Neuroepidemiology* 2017; 49: 1-17 [PMID: 28803229 DOI: 10.1159/000478702]

19 Hawkes CH, Del Tredici K, Braak H. A timeline for Parkinson's disease. *Parkinsonism Relat Disorders* 2010; 16: 79-84 [PMID: 19846332 DOI: 10.1016/j.parkreldis.2009.08.007]

20 Lin A, Zheng W, He Y, Tang W, Wei X, He R, Huang W, Su Y, Huang X, Zhou H, Xie H. Gut microbiota in patients with Parkinson's disease in southern China. *Parkinsonism Relat Disorders* 2015; 53: 82-88 [PMID: 29776865 DOI: 10.1016/j.parkreldis.2018.05.007]

21 Shannon KM, Keshavarzian A, Dodiya HB, Jakate S, Kordower JH. Is alpha-synuclein in the colon a biomarker for premotor Parkinson's disease? *Mov Disord* 2012; 27: 716-719 [PMID: 22550057 DOI: 10.1002/mds.25020]

22 Reijnders JS, Ehrt U, Weber WE, Aarsland D, Leentjens AF. A systematic review of prevalence studies of depression in Parkinson's disease. *Mov Disord* 2008; 23: 183-9; quiz 313 [PMID: 17987654 DOI: 10.1016/mj.21803]

23 Yamanishi T, Tachibana H, Ogura M, Matsu K, Toda K, Okuda B, Oka N. Anxiety and depression in patients with Parkinson's disease. *Intern Med* 2013; 52: 539-545 [PMID: 23448761 DOI: 10.2169/internmed.52.8617]

24 Cui SS, Du JJ, Fu R, Lin YQ, Huang P, He YC, Gao C, Wang HL, Chen SD. Prevalence and risk factors for depression and anxiety in Chinese patients with Parkinson disease. *BMC Geriatrics* 2017; 17: 270 [PMID: 29166864 DOI: 11.1186/s12877-017-0666-2]

25 Lin CH, Lin JW, Liu YC, Chang CH, Wu RM. Risk of Parkinson's disease following severe constipation: a nationwide population-based cohort study. *Parkinsonism Relat Disorders* 2014; 20: 1371-1375 [PMID: 25293395 DOI: 10.1016/j.parkreldis.2014.09.026]

26 Knudsen K, Fedorova TD, Belker AC, Iversen P, Østergaard K, Krogh B, Borghammer P. Objective Colonic Dysfunction is Far More Prevalent than Subjective Constipation in Parkinson's Disease: A
Colon Transit and Volume Study. *J Parkinsons Dis* 2017; 7: 359-367 [PMID: 28157109 DOI: 10.3233/JPD-161050]

28 Gökçal E, Gür VE, Selvitop R, Babacan Yıldız G, Asil T. Motor and Non-Motor Symptoms in Parkinson's Disease: Effects on Quality of Life. *Noro Psikiyatr Ars* 2017; 54: 143-148 [PMID: 28680312 DOI: 10.5152/npa.2016.12758]

29 Borovac JA. Side effects of a dopamine agonist therapy for Parkinson's disease: a mini-review of clinical pharmacology. *Yale J Biol Med* 2016; 89: 37-47 [PMID: 27505015]

30 Kulshreshtha D, Ganguly J, Jog M. Managing autonomic dysfunction in Parkinson's disease: a review of emerging drugs. *Expert Opin Emerg Drugs* 2020; 25: 37-47 [PMID: 32067502 DOI: 10.1080/14728214.2020.1729120]
