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Influence of Sociodemographic Variables on Patient and Practitioner Knowledge of Pharmacological Management Options for Parkinson's Disease

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Abstract

Introduction: *The pharmacological management of Parkinson's Disease (PD) is imperative to improve the quality of life for patients with the disease. However, the extent of knowledge among patients with PD and practitioners of pharmacological management options is unknown. Our primary aim was to investigate patient and practitioner knowledge of pharmacological management options for PD. Our secondary aim was to study the influence of sociodemographic variables on patient and practitioner knowledge of pharmacological management options for PD.*

Methodology: *The Knowledge Attitude Practice (KAP) model was adapted to develop a questionnaire that assesses patient and practitioner knowledge of pharmacological management options for PD. To determine the relationship between sociodemographic variables and patient and practitioner knowledge of pharmacological management options, basic frequency, likelihood-ratio chi-squared, Spearman's correlation, simple logistic regression, and multiple logistic regression analyses were performed.*

Results: *For patients (n = 492) and practitioners (n = 149), the most widely known pharmacological management option was Levodopa-Carbidopa immediate-release tablets, and the least-known was Procyclidine. Compared to patients, practitioners were more likely to have knowledge of most pharmacological management options (OR 1.62 - 9.38). Higher education level (OR 2.56 - 21.01), younger age (OR 0.17 - 0.32), geographical location (Europe OR 1.97 - 9.40, North America OR 0.07 - 0.44, Oceania OR 17.70 - 38.36), ethnicity (4.73 - 5.72), and employment status (OR 0.15 - 0.28) had a significant relationship with patient and practitioner knowledge of pharmacological management options.*

Conclusion: *Practitioners were more likely to have knowledge of most pharmacological management options for PD than patients. Sociodemographic variables such as education level, age, geographical*

location, ethnicity, and employment status influenced patient and practitioner knowledge of pharmacological management options.

Introduction

The pharmacological management of Parkinson's Disease (PD) symptoms is imperative to improve the quality of life for patients with the disease. Pharmacological management options, such as Levodopa, monoamine oxidase-B (MAO-B) inhibitors, and dopamine agonists, are available to provide relief for associated progressive motor (i.e., tremors, bradykinesia) and non-motor (i.e., speech problems, pain, depression, sleep disturbances, constipation) symptoms that affect quality of life and require targeted pharmacological management [1]. Levodopa is the gold-standard pharmacological management option used to relieve PD symptoms [2], yet the long-term use eventually leads to disease management complications, including motor and non-motor fluctuations [3].

Regardless of the pharmacological management option, disease management complications (i.e., motor fluctuations and dyskinesia) are expected to emerge over time and are variable for patients with PD across sociodemographic backgrounds. Contributors to the variation in complications associated with PD pharmacological management are biological and non-biological [4]. Biological contributors include genetic factors, vascular disease, dementia-associated pathology, and co-morbidities [4]. The most common forms of PD are caused by mutations in the LRRK2, PARK2, SNCA, and DJ-1 genes. These genes are associated with different phenotypes whose prevalence differs across ethnic groups [5]. Vascular disease is more common in African Americans than in White Americans. Patients with PD with additional cardiovascular risk factors have a worse prognosis [6]. African American and Hispanic patients with PD may be at a higher risk of developing cognitive symptoms [4]. African Americans have a higher frequency of APOE ε4 gene whose carriers with PD have a more rapid cognitive decline [7]. Type 2 diabetes mellitus is a common comorbidity that is more prevalent in South Asians and has been identified as a risk factor for developing PD [8].

Non-biological contributors include healthcare inequities, practitioner decisions, and under-reporting of symptoms [4]. Studies comparing European versus African patients with PD have shown that patients in Africa have greater disease severity, are taking lower doses of Levodopa, and are symptomatic longer before starting pharmacological management. African patients are more likely to be managed with anti-cholinergic medication and amantadine, whereas European patients are more likely to be managed with Levodopa, MAO-B inhibitors, and dopamine agonists [9]. In the United States, ethnic minority groups are less likely to be treated by a neurologist, leading to delays in diagnosis and pharmacological management. One explanation for the disparities in the United States is that African Americans and Chinese Americans are more likely to perceive their PD symptoms as a normal aging process and avoid seeking care [10]. In the United States and Europe, the management of PD is based on well-established clinical practice guidelines (CPGs) [11, 12], whereas in Africa, local adaptations due to variability in medication access are common [13].

Considering the variable presentation in patients with PD, as well as the range of disease management complications, it is imperative that patients and practitioners recognize the various existing and

emerging pharmacological management options. To find the most effective disease management option, patients and practitioners should be aware of the variety of available pharmacological management options. An increased awareness of pharmacological management options would assist practitioners in providing safe, individualized care. Practitioners have an essential role in educating patients to promote safe medication use. Studies have found a lack of patient-practitioner communication regarding pharmacological management options, including patients failing to report medications prescribed by other practitioners, discuss medication concerns, or account for the use of non-prescription medications or other therapies [14]. To ensure safe and individualized care is consistently provided, practitioners and patients will need to improve their communication. As communication goes both ways, patients should be willing to share their current understanding and use of medications to manage symptoms and come to their practitioner prepared to ask relevant questions. Practitioners should take the time to ask relevant questions, listen, and validate patient responses.

Increasing patients' involvement in their diagnostic and therapeutic decisions is associated with better disease management results, including improved independence, quality of life, and motor and non-motor symptoms [15]. As patients become more involved, knowledge of their PD diagnosis and health decision-making improves, leading to more individualized care opportunities that align with their values and preferences and can enhance health outcomes [16, 17]. Despite the positive consequence of individualized care, only 71% of patients with PD can identify Levodopa-Carbidopa from its trade name, and only 45-50% of patients with PD are knowledgeable of medication dosing [16]. Considering over 75% of patients with PD reported they independently manage their medications, the limited awareness of pharmacological management options is concerning [16]. Beyond Levodopa-Carbidopa, it is unknown what pharmacological management options patients are and are not aware of. There is no evidence in the literature of practitioner awareness of pharmacological management options for PD.

Our primary aim was to investigate the current knowledge of pharmacological management options in patients with PD and practitioners. Our secondary aim was to identify the influence of sociodemographic variables on patient and practitioner knowledge of pharmacological management options for PD. Determining whether patients and practitioners are knowledgeable of the various pharmacological management options could improve patient health outcomes, independence, quality of life, and motor and non-motor symptoms of PD.

Methodology

This study was approved by the Institutional Review Board at the University of Jamestown (IRB #032PHDCR).

Questionnaire Design

The Knowledge Attitude Practice (KAP) model was adapted to develop a questionnaire that assesses patient and practitioner knowledge of pharmacological management options for PD. The KAP model is a valid instrument that assesses what people know, how they feel, and how they behave regarding a specific health topic [18].

The questionnaire consisted of 11 questions and included four sections: (1) standard sociodemographic data, (2) patient or practitioner knowledge

of pharmacological and non-pharmacological management options, (3) patient or practitioner attitude toward trying or prescribing new emerging pharmacological management options, and (4) patient or practitioner attitude toward using pharmacological and non-pharmacological management options or their combination in the management of PD. In section two, pharmacological management options were listed to select from (the option to select yes if one knows the management option, or no if one does not know it), including the option to select "other" and self-report any non-listed pharmacological management options. This paper only included the data collected on the knowledge of pharmacological management options, not the non-pharmacological management options or attitudes toward management options.

Recruitment of Participants

Participants included patients with PD and medical/health practitioners such as physicians, nurses, physical therapists, occupational therapists, speech-language therapists, psychologists, and caregivers who treat or take care of patients with PD. The recruitment materials and strategies included (1) email communication to PD wellness programs, support groups, neurologists, and rehabilitation facilities worldwide; (2) flyers, including a QR code to the questionnaire handed out to participants or posted in waiting rooms of wellness programs, support groups, and hospitals; and (3) word-of-mouth. All recruitment materials and strategies included the purpose of the study, the participation benefits, the eligibility criteria, and the investigator's contact information. Informed consent was obtained from each participant before questionnaire completion, in electronic or paper form.

Using the Qualtrics power analysis, a total of 385 participants (patients and practitioners) were needed for 0.8 study power.

Data Collection and Confidentiality

Data was collected anonymously via Qualtrics questionnaires or through a paper questionnaire. Paper questionnaires were provided to participants who did not have access to or were unable to use online technology. The questionnaires were distributed in three languages (English, Latvian, and German). The KAP model has not been developed in Latvian or German. One investigator (PA), whose native language is Latvian and who has a C1 language certificate in German, translated the questionnaire into Latvian and German.

Data Analysis

Only fully completed surveys were included in the data analysis. One investigator (PA) reviewed the data for input errors and inconsistencies. The data was analyzed using STATA 18 (StataCorp LLC Stata statistical software: release 18. College Station, TX: StataCorp LLC. 2023). Descriptive statistics were performed to identify measures of central tendency and dispersion. Basic frequency analysis was used to calculate the percentages of patients and practitioners who identified knowledge of pharmacological management options. Likelihood-ratio chi-squared analysis was conducted to identify sociodemographic differences between patients and practitioners. Post hoc analysis of the likelihood-ratio chi-squared analysis was performed to identify the highest participating group for each sociodemographic variable. Spearman's correlation was performed to evaluate the relationship between sociodemographic variables and the number of pharmacological management options identified as having knowledge of. The relationships were interpreted as trivial effect size ($r < 0.10$), small effect size (0.10

≤ r < 0.30), medium effect size (0.30 ≤ r < 0.50), large effect size (0.50 ≤ r < 0.70), and very large effect size (r ≥ 0.70) [19]. Simple logistic regression was conducted to compare patient and practitioner knowledge of each individual pharmacological management option. Multiple logistic regression was utilized to compare patient and practitioner knowledge of each individual pharmacological management option while controlling for sociodemographic variables that could influence that outcome. The reference factor variable for age was "18 -45 years old", for ethnicity was "White/ Caucasian", for education level was "less than high school", for employment status was "unemployed", and for geographical location was "North America". Odds ratios (ORs) were calculated to assess relationships between sociodemographic variables and patient and practitioner knowledge of each individual pharmacological management option. The ORs were interpreted as trivial effect size (OR < 1.5), small effect size (1.5 ≤ OR < 2.5), medium effect size (2.5 ≤ OR < 4), large effect size (4 ≤ OR < 10), and very large effect size (OR ≥ 10) [19]. A p-value of less than 0.05 was considered a significant difference for all analyses.

Results

Characteristics of Participants

From February 2024 until May 2024, 641 participants (patients = 492; practitioners = 149) fully completed the questionnaire. Due to the nature of the study design, it was not possible to determine the survey response rate. Of the participants, 76.8% were patients with PD and 23.2% were practitioners. Of the patients with PD, the majority were male (50.4%), White/Caucasian (94.3%), aged 66 or above (64.4%), had graduate-level education (39.4%), were retired (75.8%), and resided in North America (70.9%). The practitioners included physicians, nurses, therapists, physical therapists, occupational therapists, speech-language therapists, psychologists, and caregivers. Of the practitioners, the majority were female (79.9%), White/Caucasian (86.6%), aged 46 to 65 (39.6%), had graduate-level education (59.7%), were employed (68.5%), and resided in North America (84.6%) (Table 1). The likelihood-ratio chi-squared analysis indicated that there were statistically significant differences (p < 0.01 – 0.05) between patients and practitioners for all sociodemographic variables. There were significantly more female practitioners, White/Caucasian patients, 18- to 45-year-old practitioners, practitioners with graduate-level education, employed practitioners, and practitioners residing in North America (Table 1).

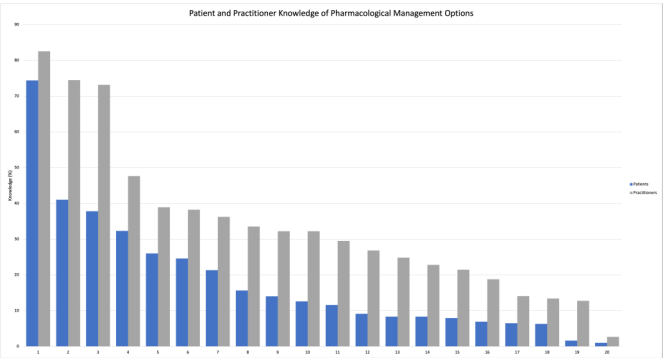
Table 1

Results from Likelihood Ratio Chi-Squared Analysis with the Patient and Practitioner Groups

Sociodemographic Variable	Patients (n=492)		Practitioners (n=149)			
	n	%	n	%	chi2	Pr
Sex					45.6	< 0.01
Female	244	49.6	119	79.9		
Male	248	50.4	30	20.1		
Ethnicity					10.7	< 0.05
White/Caucasian	464	94.3	129	86.6		
Asian/Pacific Islander	9	1.8	10	6.7		
Hispanic/Latino	9	1.8	6	4.0		
Black/African American	3	0.6	1	0.7		
Other/Mixed	7	1.4	3	2.0		

Age					132.3	< 0.01
18-45	10	2.0	50	33.6		
46-65	165	33.5	59	39.6		
66 or above	317	64.4	40	26.8		
Education					40.8	< 0.01
Less than high school	33	6.7	1	0.7		
High school	100	20.3	10	6.7		
Undergraduate-level	165	33.5	49	32.9		
Graduate-level	194	39.4	89	59.7		
Employment					158.8	< 0.01
Unemployed	14	2.8	2	1.3		
Employed	77	15.7	102	68.5		
Retired	373	75.8	35	23.5		
Retired but employed	26	5.3	7	4.7		
Pursuing higher education	2	0.4	3	2.0		
Location					12.83	< 0.01
North America	349	70.9	126	84.6		
Europe	129	26.2	22	14.8		
Other	14	2.8	1	0.7		

The frequency distribution of patient and practitioner knowledge of pharmacological management options is presented in Figure 1. The most-widely known pharmacological management option by both populations was Levodopa-Carbidopa immediate-release tablets, which were known by 74.4% of patients and 82.6% of practitioners. This was followed by Levodopa-Carbidopa controlled-release tablets, which were known by 41.1% of patients and 74.5% of practitioners, and Levodopa-Carbidopa extended-release capsules, which were known by 37.8% of patients and 73.2% of practitioners.



The least-known pharmacological management option by both populations was the anticholinergic drug Procyclidine, which was known by 1.0% of patients and 2.7% of practitioners. This was followed by Trihexyphenidyl/Benzhexol, which was known by 1.6% of patients and 12.6% of practitioners, and Safinamide, which was known by 6.3% of patients and 13.4% of practitioners.

Sociodemographic Relationship with Pharmacological Knowledge

There was a small and statistically significant relationship between the number of pharmacological management options the participants were aware of and the type of participant (patient/practitioner) ($r = 0.27$, $p < 0.01$), education level ($r = 0.20$, $p < 0.01$), employment status ($r = -0.23$, $p < 0.01$), or geographical location ($r = 0.10$, $p = 0.01$). There was a medium and statistically significant relationship between the number of pharmacological management options the participants were aware of and age ($r = -0.31$, $p < 0.01$). There was a trivial and statistically non-significant relationship between the number of pharmacological management options the participants were aware of and sex ($r = -0.07$, $p = 0.09$) or ethnicity ($r = 0.05$, $p = 0.23$).

Simple Logistic Regression of Patient and Practitioner Knowledge

Simple logistic regression revealed that practitioners were significantly more likely to have knowledge of most pharmacological management options. Practitioners were significantly more likely

to have knowledge of various Levodopa-Carbidopa medications, with ORs ranging from 1.63 to 5.23. For Levodopa-Carbidopa immediate-release tablets, controlled-release tablets, and extended-release capsules, the ORs ranged between 1.63 and 4.75, while for enteral suspension, subcutaneous delivery system ND0612, and intestinal gel, the ORs were higher, ranging from 4.19 to 5.23. Practitioners were significantly more likely to have knowledge of other PD medications, with ORs ranging from 1.62 to 9.38, with most medications having ORs between 2.17 and 3.68. The highest OR was observed for Trihexyphenidyl/Benzhexol (OR = 9.38), followed by Amantadine and Entacapone (ORs = 2.79 and 2.80, respectively) (Table 2).

Table 2

Simple Logistic Regression of Pharmacological Management Options (OR [95% CI])

Pharmacological Option	Patient/Practitioner
LD-CD IR tabs.	1.63* [1.02, 2.60]
LD-CD CR tabs.	4.19** [2.78, 6.32]
LD-CD ent. susp.	4.75** [2.83, 7.96]
LD-CD ER caps.	4.48** [2.99, 6.73]
LD-CD ND0612	5.23** [3.27, 8.36]
LD-CD int. gel	3.68** [2.18, 6.22]
LD-CD-Ent. tabs.	2.57** [1.66, 3.97]
LD inh. powder	3.30** [2.13, 5.09]
Selegiline	2.72** [1.79, 4.13]
Rasagiline	1.30 [0.89, 1.90]
Safinamide	2.17* [1.19, 3.97]
Ropinirole	2.35** [1.58, 3.48]
Apomorphine	2.94** [1.80, 4.80]
Pramipexole	1.62* [1.09, 2.39]
Rotigotine	2.55** [1.51, 4.28]
Entacapone	2.80** [1.78, 4.42]
Opicapone	1.91* [1.08, 3.35]
Amantadine	2.79** [1.91, 4.09]
Procyclidine	2.69 [0.71, 10.14]
THP/Benzhexol	9.38** [4.04, 21.78]

*$p < 0.05$

**$p < 0.01$

Sociodemographic Variables of Interest in Multiple Logistic Regression

Multiple logistic regression analysis revealed that patients and practitioners with a higher education level were significantly more likely to have knowledge of most pharmacological management options. In terms of Levodopa-Carbidopa medications, patients and practitioners with a higher education level were significantly more likely to have knowledge of controlled-release tablets (OR = 3.66, $p < 0.01$), extended-release capsules (OR = 2.56, $p < 0.05$), subcutaneous delivery system ND0612 (OR = 19.38, $p < 0.01$) and Levodopa inhalation powder (OR = 21.01, $p < 0.01$). In terms of other PD medications, patients and practitioners with a higher education level were more likely to have knowledge of Selegiline (OR = 4.89, $p = 0.01$), Ropinirole (OR = 2.96, $p = 0.03$), Apomorphine (OR = 5.31, $p = 0.01$), Entacapone (OR = 4.77, $p = 0.01$), Opicapone (OR = 5.48, $p = 0.01$), and Amantadine (OR = 5.86, $p < 0.01$) (Table 3). Patients and practitioners with a lower education level were significantly more likely to have knowledge of Procyclidine (OR = 0.07, $p = 0.04$) and Trihexyphenidyl/Benzhexol (OR = 0.22, $p = 0.01$) (Table 3).

Patients and practitioners of a younger age were significantly more likely to have knowledge of some pharmacological management options, including Levodopa-Carbidopa-Entacapone tablets (OR 0.26, $p < 0.01$), and other PD medications such as Rasagiline (OR 0.37, $p = 0.02$), Ropinirole (OR 0.22, $p < 0.01$), Pramipexole (OR 0.25, $p < 0.01$), Entacapone (OR 0.32, $p = 0.03$), Opicapone (OR 0.26, $p = 0.04$), and Amantadine (OR 0.11, $p < 0.01$) (Table 3). Patients and practitioners of an older age were significantly more likely to have

knowledge of Levodopa inhalation powder (OR 2.59, p= 0.02) (Table 3).

Patients and practitioners in North America were significantly more likely to have knowledge of Levodopa-Carbidopa immediate-release tablets (OR = 0.44, p < 0.01) compared to those in Europe. In contrast, patients and practitioners in Europe were significantly more likely to have knowledge of Levodopa-Carbidopa-Entacapone tablets (OR = 2.16, p < 0.01) compared to those in North America. In terms of other PD medications, patients and practitioners in Europe were significantly more likely to have knowledge of Rasagiline (OR = 2.41, p < 0.01), Safinamide (OR = 9.40, p < 0.01), Pramipexole (OR = 6.08, p < 0.01), Rotigotine (OR = 3.56, p < 0.01), and Trihexyphenidyl/Benzhexol (OR = 3.15, p = 0.02) compared to those in North America (Table 3).

Patients and practitioners in North America were significantly more likely to have knowledge of Levodopa-Carbidopa immediate-release tablets (OR = 0.07, p = 0.04) compared to those in Asia. Meanwhile, patients and practitioners in Oceania were significantly more likely to have knowledge of Pramipexole (OR = 17.70, p < 0.02) and Opicapone (OR = 38.36, p < 0.01) compared to those in North America (Table 3).

Patients and practitioners of Hispanic/Latino ethnicity were significantly more likely than those of White/Caucasian ethnicity to have knowledge of some pharmacological options, including Levodopa-Carbidopa intestinal gel (OR = 4.73, p = 0.02), Entacapone (OR = 4.87, p = 0.01), and Opicapone (OR = 5.23, p = 0.04). In contrast, patients and practitioners of Asian/Pacific Islander ethnicity patients and practitioners were significantly more likely than those of White/Caucasian ethnicity to have knowledge of Rotigotine (OR = 4.91, p = 0.02) and Opicapone (OR = 5.72, p = 0.01) (Table 3).

Unemployed patients and practitioners were significantly more likely than employed patients and practitioners to have knowledge of some pharmacological management options, including Safinamide (OR 0.20, p = 0.04), Pramipexole (OR 0.28, p = 0.04), and Opicapone (OR 0.15, p = 0.02) (Table 3).

There was no significant relationship between sex and patient and practitioner knowledge of pharmacological management options (Table 3).

Table 3

Multiple Logistic Regression of Pharmacological Management Options (OR [95% CI])

Sociodemographic Variable	LD-CD IR tabs.	LD-CD CR tabs.	LD-CD ent. susp.	LD-CD ER caps.	LD-CD ND0612	LD-CD int. gel	LD-CD -Ent. tabs.	LD inh. powder	Selegiline	Rasagiline	Safinamide	Ropinirole	Apomorphine	Pramipexole	Rotigotine	Entacapone	Opicapone	Amantadine	Procyclidine	THP/ Benzhexol
Sex	0.94 [0.63, 1.39]	1.25 [0.88, 1.79]	1.22 [0.66, 2.24]	1.22 [0.85, 1.75]	1.24 [0.70, 2.20]	1.19 [0.64, 2.22]	1.01 [0.63, 1.64]	1.13 [0.69, 1.86]	1.43 [0.90, 2.25]	1.03 [0.71, 1.50]	0.74 [0.36, 1.52]	1.19 [0.79, 1.81]	1.18 [0.67, 2.09]	0.99 [0.65, 1.51]	0.68 [0.36, 1.26]	2.58 [1.34, 4.99]	0.58 [0.30, 1.13]	0.80 [0.54, 1.20]	1.02 [0.22, 4.78]	0.94 [0.35, 2.52]
Age																				
46-65	0.68 [0.25, 1.81]	1.22 [0.57, 2.61]	2.06 [0.85, 5.01]	1.16 [0.52, 2.56]	2.16 [0.93, 5.05]	1.62 [0.67, 3.95]	0.71 [0.33, 1.52]	2.59* [1.15, 5.86]	0.85 [0.40, 1.79]	0.91 [0.45, 1.83]	1.13 [0.37, 3.46]	0.52 [0.25, 1.07]	1.20 [0.51, 2.80]	0.50 [0.24, 1.07]	1.09 [0.43, 2.78]	0.67 [0.29, 1.53]	0.71 [0.25, 1.99]	0.47* [0.23, 0.98]	0.29 [0.01, 10.85]	1.08 [0.36, 3.25]
66 or above	0.63 [0.21, 1.87	0.84 [0.35, 2.00]	0.96 [0.29, 3.12]	0.49 [0.20, 1.20]	0.67 [0.23, 1.97]	1.64 [0.46, 5.90]	0.26** [0.10, 0.68]	0.90 [0.33, 2.45]	0.52 [0.20, 1.34]	0.37* [0.16, 0.86]	0.30 [0.07, 1.27]	0.22** [0.09, 0.54]	0.58 [0.19, 1.75]	0.25** [0.10, 0.61]	0.56 [0.17, 1.90]	0.32* [0.12, 0.90]	0.26* [0.07, 0.95]	0.11** [0.05, 0.26]		0.25 [0.04, 1.59]

Ethnicity																					
Asian/ Pacific Islander	2.83 [0.33, 24.09]	2.00 [0.50, 8.01]	0.94 [0.24, 3.64]	0.64 [0.19, 2.19]	1.26 [0.37, 4.31]	0.96 [0.23, 3.97]	1.02 [0.29, 3.58]	1.28 [0.38, 4.37]	1.19 [0.36, 3.98]	1.30 [0.43, 3.94]	3.25 [0.69, 15.27]	2.68 [0.79, 9.13]	1.64 [0.45, 5.97]	1.14 [0.34, 3.76]	4.91* [1.37, 17.60]	2.58 [0.76, 8.77]	5.72* [1.45, 22.55]	2.09 [0.61, 7.14]	8.06 [0.69, 94.31]	2.10 [0.47, 9.37]
Hispanic/ Latino	0.37 [0.11, 1.20]	1.67 [0.50, 5.53]	0.94 [0.18, 4.97]	0.51 [0.15, 1.74]	3.51 [0.89, 13.87]	4.73* [1.26, 17.80]	2.24 [0.63, 8.05]	2.10 [0.60, 7.33]	2.58 [0.76, 8.78]	1.85 [0.59, 5.85]	1.64 [0.23, 11.76]	1.65 [0.47, 5.75]	2.31 [0.55, 9.70]	1.72 [0.47, 6.32]	3.98 [0.91, 17.46]	4.87* [1.38, 17.24]	5.23* [1.08, 25.26]	0.83 [0.24, 2.89]		4.11 [0.71, 23.70]
Black/ African American	1.42 [0.09, 22.54]	1.26 [0.13, 11.92]		0.25 [0.02, 3.96]			2.84 [0.19, 42.08]		2.20 [0.14, 33.92]	2.28 [0.26, 19.74]	13.77 [0.57, 332.40]	1.92 [0.13, 28.14]	4.98 [0.21, 116.43]	1.02 [0.08, 12.82]	5.05 [0.24, 108.02]	2.78 [0.20, 39.33]		0.92 [0.07, 11.98]		
Mixed/ Other	0.33 [0.09, 1.26]	2.23 [0.53, 9.44]	0.42 [0.03, 5.03]	0.52 [0.12, 2.24]	0.32 [0.03, 3.73]			0.23 [0.02, 2.49]	0.36 [0.04, 3.40]	0.49 [0.09, 2.52]	1.28 [0.08, 20.60]	1.25 [0.27, 5.69]		0.86 [0.15, 4.94]		0.55 [0.06, 5.23]		0.60 [0.13, 2.77]		
Education																					
High School	0.75 [0.31, 1.82]	1.31 [0.54, 3.17]	0.76 [0.13, 4.52]	0.69 [0.28, 1.68]	2.02 [0.22, 18.63]	1.66 [0.18, 15.47]	1.44 [0.40, 5.13]	4.32 [0.51, 36.35]	1.64 [0.47, 5.67]	0.80 [0.33, 1.93]	0.88 [0.27, 2.93]	1.03 [0.39, 2.73]	0.68 [0.16, 2.85]	1.16 [0.48, 2.82]	0.45 [0.13, 1.54]	1.47 [0.41, 5.24]	2.09 [0.56, 7.77]	2.25 [0.67, 7.61]	0.46 [0.07, 2.96]	0.36 [0.08, 1.63]
Undergrad-uate	0.79 [0.33, 1.91]	1.95 [0.82, 4.62]	1.25 [0.24, 6.52]	1.01 [0.42, 2.42]	3.70 [0.44, 31.11]	1.86 [0.21, 16.21]	1.93 [0.57, 6.52]	6.83 [0.84, 55.59]	1.75 [0.52, 5.86]	1.20 [0.51, 2.82]	0.33 [0.09, 1.28]	1.24 [0.48, 3.20]	1.63 [0.46, 5.77]	0.87 [0.37, 2.08]	0.48 [0.15, 1.52]	1.06 [0.30, 3.72]	0.42 [0.09, 2.00]	2.81 [0.85, 9.28]	0.07* [0.01, 0.83]	0.22* [0.07, 0.73]
Graduate	1.13 [0.48, 2.67]	1.74 [0.75, 4.04]	1.49 [0.30, 7.44]	1.44 [0.62, 3.35]	3.83 [0.46, 31.56]	2.30 [0.27, 19.44]	3.48* [1.08, 11.20]	5.28 [0.66, 42.60]	2.86 [0.89, 9.18]	1.54 [0.67, 3.52]	0.59 [0.19, 1.81]	1.25 [0.50, 3.13]	1.75 [0.52, 5.88]	0.89 [0.39, 2.03]	0.61 [0.21, 1.77]	2.15 [0.66, 7.05]	2.75 [0.82, 9.29]	2.49 [0.77, 8.11]	0.13* [0.02, 0.95]	0.26* [0.09, 0.79]
Doctorate	1.97 [0.72, 5.42]	3.65** [1.44, 9.26]	3.94 [0.76, 20.46]	2.56* [1.01, 6.49]	19.38** [2.31, 162.91]	7.58 [0.88, 64.93]	4.64* [1.34, 16.07]	21.01** [2.55, 173.18]	4.89* [1.44, 16.61]	1.62 [0.65, 4.01]	2.41 [0.72, 8.08]	2.96* [1.11, 7.88]	5.31* [1.49, 18.96]	1.82 [0.73, 4.56]	3.02 [0.99, 9.17]	4.77* [1.37, 16.61]	5.48* [1.45, 20.72]	5.86** [1.71, 20.08]		
Employment																					
Employed	0.67 [0.17, 2.70]	0.65 [0.21, 2.02]	0.41 [0.09, 1.81]	0.39 [0.12, 1.26]	0.77 [0.13, 4.43]	2.02 [0.23, 18.00]	0.51 [0.13, 1.94]	0.50 [0.13, 1.85]	0.47 [0.14, 1.60]	0.50 [0.16, 1.52]	0.20* [0.04, 0.94]	0.37 [0.12, 1.16]	0.28 [0.07, 1.10]	0.28* [0.09, 0.91]	0.81 [0.15, 4.48]	0.55 [0.12, 2.43]	0.15* [0.03, 0.73]	0.70 [0.21, 2.33]	15.58 [0.41, 588.15]	0.38 [0.03, 4.20]
Retired	0.50 [0.13, 2.01]	0.88 [0.29, 2.72]	0.41 [0.09, 1.91]	0.42 [0.13, 1.34]	1.23 [0.21, 7.20]	0.79 [0.08, 7.60]	0.86 [0.22, 3.28]	0.62 [0.17, 2.34]	0.47 [0.14, 1.63]	0.49 [0.16, 1.49]	0.27 [0.06, 1.29]	0.60 [0.19, 1.87]	0.30 [0.07, 1.19]	0.36 [0.11, 1.17]	0.74 [0.13, 4.20]	1.35 [0.31, 5.98]	0.33 [0.07, 1.55]	2.05 [0.62, 6.79]		0.54 [0.05, 6.53]
Retired, but employed	0.46 [0.09, 2.24]	1.17 [0.31, 4.44]	0.53 [0.08, 3.39]	0.40 [0.10, 1.56]	1.48 [0.19, 11.23]	0.94 [0.07, 12.46]	1.27 [0.26, 6.31]	0.59 [0.11, 3.07]	0.71 [0.16, 3.13]	0.71 [0.19, 2.67]	0.62 [0.09, 4.34]	0.73 [0.18, 2.92]	0.46 [0.08, 2.65]	0.43 [0.10, 1.79]	1.42 [0.18, 10.98]	1.17 [0.20, 6.93]	0.35 [0.04, 2.74]	2.85 [0.69, 11.72]		0.49 [0.02, 14.29]
Pursuing higher education	0.11 [0.01, 1.38]	0.48 [0.05, 4.57]		0.41 [0.03, 4.84]	0.71 [0.03, 14.89]					0.35 [0.03, 3.56]				0.08 [0.00, 1.24]				0.13 [0.01, 1.96]		1.31 [0.04, 42.28]
Continent																					
Europe	0.44** [0.27, 0.72]	1.36 [0.86, 2.14]	1.05 [0.52, 2.12]	0.90 [0.57, 1.43]	1.18 [0.61, 2.27]	0.92 [0.44, 1.92]	2.16** [1.28, 3.65]	1.02 [0.58, 1.82]	1.66 [0.99, 2.79]	2.41** [1.54, 3.78]	9.40** [4.20, 21.07]	1.97** [1.21, 3.21]	2.98** [1.62, 5.49]	6.08** [3.74, 9.88]	3.56** [1.84, 6.92]	2.15** [1.22, 3.79]	6.85** [3.42, 13.72]	0.81 [0.49, 1.32]	1.44 [0.27, 7.70]	3.15* [1.18, 8.41]
Asia	0.07* [0.01, 0.86]	0.13 [0.01, 1.64]	1.48 [0.12, 18.86]	0.19 [0.02, 2.17]			2.06 [0.25, 16.71]		0.57 [0.05, 6.75]	1.09 [0.16, 7.33]	1.70 [0.10, 28.73]	0.67 [0.08, 5.59]	0.90 [0.07, 11.71]	3.63 [0.51, 26.01]	0.52 [0.04, 7.14]	0.64 [0.05, 8.22]		0.57 [0.07, 4.66]		
Oceania	0.82 [0.08, 8.28]	1.6- [0.21, 12.01]			5.27 [0.46, 60.31]	6.77 [0.63, 72.47	2.89 [0.27, 30.90]			2.66 [0.34, 20.77]		4.48 [0.56, 35.52]	5.82 [0.54, 62.91]	17.70* [1.69, 185.65]			38.36** [2.92, 504.29]	2.14 [0.27, 17.16]		
South America																				
Africa	0.30 [0.04, 2.42]			0.59 [0.05, 6.54]					2.65 [0.25, 28.33]	3.52 [0.43, 28.97]								0.70 [0.06, 7.76]		

Legend

LD-CD IR tabs.: Levodopa-Carbidopa immediate-release tablets

LD-CD CR tabs.: Levodopa-Carbidopa controlled-release tablets

LD-CD ent. susp.: Levodopa-Carbidopa enteral suspension

LD-CD ER caps.: Levodopa-Carbidopa extended-release capsules

LD-CD ND0612: Levodopa-Carbidopa subcutaneous delivery system ND0612

LD-CD int. gel: Levodopa-Carbidopa intestinal gel

LD-CD-Ent. tabs.: Levodopa-Carbidopa-Entacapone tablets

LD inh. powder: Levodopa inhalation powder

THP: Trihexyphenidyl

*p < 0.05

**p < 0.01

Discussion

To our knowledge, this is the first study to report that practitioners were significantly more likely than patients to have knowledge of most pharmacological management options for PD. This knowledge gap exists even for the most common pharmacological management options, such as Levodopa-Carbidopa controlled-release tablets versus immediate-release tablets. The knowledge gap is even more pronounced when identifying alterna-

tive Levodopa-Carbidopa options, such as extended-release capsules or enteral suspension. The significant gap in knowledge of pharmacological management options could contribute to poorer patient outcomes, potential sentinel events, and decreased overall quality of life for patients with PD [20]. From a sociodemographic perspective, we found that the education level, age, geographical location, ethnicity, and employment status of patients and practitioners were associated with their knowledge of various pharmacological management options.

Education Level and Knowledge

Patients and practitioners with a higher education level were more likely to have knowledge of most pharmacological management options. Consistent with others, we found that education level is significantly related to health knowledge levels [21]. As prescribers with a graduate-level education, physicians are expected to possess more knowledge of pharmacological management options. In contrast, patients' education levels are more variable and less likely to focus on health or medication. This variability in education levels highlights the need for approaches to equip patients with the knowledge and skills necessary, as their active participation in disease management may improve outcomes [15].

Patient knowledge and involvement in their management options and health decision-making have been shown to improve adherence, engagement, and health outcomes [15]. For patients with PD, health literacy, often associated with education level, may partially explain the disparities in knowledge among the pharmacological management options [22]. Patients with a higher education level may be more likely to research pharmacological management options independently and consider practitioners' recommendations. A higher education may also assist patients to better understand, interpret, and investigate pharmacological management options [23].

Since many patients with PD have decreased health literacy, practitioners should consider the patient's ability to find, interpret, and utilize health information when providing education on pharmacological management options [24]. In populations with lower education levels, the associated decrease in health literacy may be a barrier to shared decision-making to select the most appropriate pharmacological management option for a patient with PD. To improve patients' pharmacological knowledge and improve shared decision-making, education efforts should focus on recognition, indication, dosage schedule, and side effects of common medications to improve health literacy [23]. Our findings of discrepancies between patient and practitioner knowledge of pharmacological management options suggest that the use of a valid and reliable instrument (i.e., the Health Literacy Survey 2024-2026 [25] or the Health Literacy Instrument for Adults [26]) to assess patients' health literacy should be included as part of the standard assessment for PD.

Age and Knowledge

Younger patients and practitioners are more likely to use newer technology and resources that improve proficiency in obtaining information on pharmacological management options for their condition [27]. Therefore, our findings that patients and practitioners of a younger age were more likely to have knowledge of pharmacological management options were not surprising. However, our findings are likely an extension of the already identified knowledge gap between patients and practitioners,

as only 2% of patients with PD and approximately one-third of practitioners were classified in the younger group. While caution should be used with interpretation, our findings may also be explained in that younger practitioners have more recent medical education and are more likely to have knowledge of online databases such as PubMed, which provides the latest updates and guidelines on new medications [28]. On the other hand, practitioners who completed their medical education longer ago may not have the latest medications included in their formal training or have the skill set to efficiently access the needed information [29]. Older patients and practitioners could benefit from educational initiatives aimed at increasing technology use for obtaining health-related information, particularly as the incidence and prevalence of PD increases in an aging population.

Geographical Location and Knowledge

The geographical location of patients and practitioners was found to influence the knowledge of pharmacological management options. Disparities in healthcare systems across geographical locations may explain these variations. For instance, in some European countries, practitioners prescribe the medication that the statutory health insurance will cover, either in full or with the patient needing to make a small additional payment [30]. Moreover, not all practitioners in all geographical locations are aware of the recently approved pharmacological management options leading to variability in recommendations across countries [31]. To decrease the unnecessary variability in pharmacological management recommendations, national authorities should routinely review clinical practice guidelines, develop medication monitoring registries, and create policies to foster evidence-based decision-making to improve the health and well-being of patients with PD [31].

Ethnicity and Knowledge

Ethnicity was found to influence the knowledge of pharmacological management options. We found that patients and practitioners of Hispanic/Latino and Asian/Pacific Islander ethnicities were more likely to have knowledge of some pharmacological management options than their White/Caucasian counterparts. This finding was surprising as others have reported that ethnic minority groups are less likely to have knowledge of medications [32, 33]. For ethnic minority groups, there are documented systemic challenges to obtaining medication information. These challenges include language barriers, cultural differences, and low socioeconomic status [33]. Our conflicting findings indicate that future research is needed to further investigate how ethnic differences between patients and practitioners influence the knowledge of pharmacological management options.

Employment Status and Knowledge

Unemployed patients and practitioners were more likely than employed patients and practitioners to have knowledge of some pharmacological management options. However, these findings may be misleading as only 2.5% of the study participants were unemployed. Prior research has found that unemployed patients are less likely to have knowledge of medications. For instance, Nguyen et al., 2022 found that loss of employment for patients is linked to lower medication intake due to loss of insurance and income [34]. Others have reported that loss of patient employment is linked to fewer or no practitioner visits, which reduces patient knowledge of pharmacological management options [35]. In light of the evidence, our findings should be interpreted

with caution and indicate that future research is needed to further investigate how employment status of patients and practitioners influences the knowledge of pharmacological management options.

Sex and Knowledge

We found that the sex of patients and practitioners did not influence their knowledge of pharmacological management options. Saunders-Pullman et al., 2014 found that it took 61% longer for females to visit a practitioner after the onset of PD symptoms than males [36]. However, there is conflicting evidence on the role of sex and the knowledge of pharmacological management options. Multiple studies have found that females are more likely to have knowledge of medications [37, 38]. An observational study found that females use more healthcare services than males [39]. The increased interaction with practitioners may lead to females being more knowledgeable of pharmacological management options than males. Future research is needed to provide insight into the relationship between sex and knowledge of pharmacological management options.

Clinical Relevance

From a clinical perspective, patients' lack of knowledge regarding pharmacological management options for PD can have serious consequences. For instance, patients may take immediate-release Levodopa tablets that wear off, leading to motor fluctuations between medication doses [3]. In contrast, controlled-release tablets or extended-release capsules help maintain a more consistent level of medication in the body, potentially relieving motor symptoms between doses [40]. An increased knowledge of the various pharmacological management options could facilitate a change in medication to improve health outcomes and quality of life for patients with PD [41]. Those unaware of alternative pharmacological management options may struggle to advocate for themselves and, as a result, have poorer health outcomes and reduced quality of life.

An important consideration is that, as PD progresses, more than 80% of patients develop dysphagia [42]. The associated swallowing impairment leads to complications with medication intake, aspiration, and malnutrition, which are major causes of death in PD [42]. For patients with dysphagia, oral medications may no longer be a safe management option due to the risk of aspiration [43]. While Levodopa-Carbidopa is available in different forms, including intestinal gel, enteral suspension, and inhalation powder, our study shows that patients may not be aware of these alternatives. As a result, patients may continue taking oral medications without realizing safer, more effective options are available [44].

Van Halteren et al., 2020 presented an integrated and personalized care management model for patients with PD. This model has five core elements: (1) care coordination, (2) patient navigation, (3) information provision, (4) early detection of signs and symptoms through proactive monitoring, and (5) process monitoring [45]. All five core elements aim to increase knowledge of the disease and management options to ensure the patient is diagnosed early and has access to a practitioner who will develop a personalized care plan. Implementing this model and then re-examining knowledge of pharmacological management options and disease outcomes could be a practical approach for objectively evaluating a consistent strategy to be utilized by practitioners. Future research should investigate the

quality of communication between patients with PD and practitioners to identify what might be causing the knowledge gap in pharmacological management options.

Study Limitations

This study surveyed practitioners, including physicians, nurses, physical therapists, occupational therapists, speech-language therapists, psychologists, and caregivers. Since not all of these practitioners are prescribers, this might have affected the results of the knowledge of pharmacological management options among practitioners. While the study included participants from different ethnic and geographic backgrounds, some ethnicities and geographies were underrepresented. Knowledge awareness was a dichotomous (yes or no) variable, which does not provide an indication of the level of knowledge. This was beyond the scope of our investigation.

Conclusion

We found that practitioners are more likely to have knowledge of most pharmacological management options for PD than patients. Sociodemographic variables such as education level, age, geographical location, ethnicity, and employment status influenced patient and practitioner knowledge of pharmacological management options. From a clinical perspective, the knowledge gap between patients and practitioners may significantly impact patient care. Practitioners should consider sociodemographic variables when providing information to their patients. Future research should explore how communication between patients and practitioners influences patient knowledge of pharmacological management options for PD.

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