Movement Disorders
CLINICAL PRACTICE

RESEARCH ARTICLE

The Feasibility and Practical Utility of Virtual Visits for Patients with Parkinson's Disease in Different World Regions

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Abstract: Background: Overcoming existing access barriers is crucial for better-specialized health care of patients with Parkinson's disease (PD).

Objective: The aim of the study was to compare the access and visit quality/acceptability between in-office and virtual telemedicine visits.

Methods: This was an international, randomized, case-control, prospective, observational study. Patients were randomly assigned either to the control group (in-person/in-office visits at baseline, 3, 6, 9, and 12 months) or to the study group (in-office visits at baseline, 6, and 12 months, and telemedicine visits at 3 and 9 months). Telemedicine visits were conducted using videoconferencing apps that were readily accessible to the patient/caregivers. Outcomes were feasibility, usability, and the noninferiority of telemedicine compared to in-office visits in PD patients regarding clinical progression and initiation of pharmacological/nonpharmacological treatments over 1-year follow-up.

Results: We included 209 PD patients from 6 countries (Nigeria, Spain, Saudi Arabia, South Korea, Egypt, and Uruguay), mean age 64.9 ± 12.2 years, 59% males, median Hoehn & Yahr stage 2 (1–4). Overall, disease progression (MDS-Unified PD rating scale), quality of life (PD-Quality of life 39-items) scores, and therapeutic changes were similar in both groups. After 1 year, 124 patients 48.3%, (control group) and 52.1% (study group) completed the visits ($P = 0.52$), with a similar high rate of patient's satisfaction with the visits ($P = 0.57$).

Conclusions: This study represents real-world telemedicine practice in different world regions using a telemedicine approach complementary to in-person visits. Based on these results, feasibility, clinical management, PD disease progression, and patient's quality of life are similar when using telemedicine versus in-office visits. Future research should explore ways to integrate different healthcare technologies for long-term PD management.

The global prevalence of Parkinson's disease (PD) is rapidly increasing, driven by aging populations and improved diagnostic capabilities. By 2040, it is estimated that the number of people living with PD will exceed 14 million, with the greatest burden expected in low- and middle-income countries.[1] Despite this rising prevalence, significant healthcare access disparities persist

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Zoltan Mari and Esther Cubo shared senior (last) author role.

[Correction added on 10 September 2025 after first online publication: Zoltan Mari's degree has been updated and the author contribution statement has been added.]

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across regions and within countries. In many low-resource settings, individuals with PD face challenges such as a lack of specialized healthcare providers, limited availability of medications like levodopa, and social stigmatization of neurological disorders.[2] Even in high-income countries, access to advanced therapies, including deep brain stimulation and multidisciplinary care, remains unequal, especially in medically underserved areas.[3,4] Addressing these inequities requires international collaboration to strengthen healthcare infrastructure, train neurologists, and improve the availability of essential therapies worldwide.

According to the Internet World Stats website,[5] Internet penetration across the world is globally increasing with an estimated average rate of 69% (95.4% in South Korea, 89.3% in Spain, 73.9% in Egypt, 63.8% in Nigeria, 92.4% in the United States, 96.9% in Saudi Arabia, 84.9% in Uruguay, among others). The increased access to the Internet and the development of Information and Communication Technologies (ICTs) can create equitable healthcare systems and services in underserved areas.[6] Telemedicine (TM) programs are particularly suited to evaluating patients with PD, primarily because most of the physical examination findings are visual. TM uses ICTs to overcome geographical barriers and increase access to healthcare services, and it is particularly beneficial for rural and underserved communities, groups that traditionally lack access to health care. Moreover, the emergence of TM during the COVID-19 pandemic has revolutionized the management of its use in PD.[7] In this regard, although there is growing evidence supporting the TM in terms of cost and time savings, as well as patients' and physicians' satisfaction,[8] its quality in neurological assessment might be limited, especially for the assessment of particular signs such as rigidity, or tremor speed, and myoclonus when using videoconferences with a low frame rate.

However, most of the reports in the literature about TM and PD come from developed countries.[9] In low- and middle-income countries, cultural acceptance and awareness may differ even if the technical infrastructure is available, limiting TM's reported impact and the extrapolation of scientific findings from developed countries. Considering the lack of knowledge about TM for PD in different health settings, we aimed to study and compare the feasibility, practical utility, and satisfaction in different world regions.

Methods

This was a longitudinal, observational, case-control study (identifier: NCT 04695353). We included a convenience sample of outpatients ⟩18 years old diagnosed with idiopathic PD based on the International PD Movement Disorder Society (MDS) criteria,[10,11] from Europe (Spain), Africa (Nigeria and Egypt), Middle East (Saudi Arabia), Asia (South Korea), and South America (Uruguay). To be enrolled, patients and/or their care partners had access to and were able to conduct a videoconference using mobile technology with a home/community Wi-Fi connection, with or without caregiver/other support. We excluded patients diagnosed with other types of parkinsonism and those unable to conduct a videoconference. After obtaining written informed consent, the patients were invited to participate and randomly assigned to either a control group (baseline, 3,6, 9, and 12-month in-office visits), or to a study group (baseline, 6, and 12-month in-office visits, and 3 and 9-month TM visits) (Fig. 1). Patients were randomized (1:1) using a random number generator in Excel.

Ethics, Data Protection, and Legal Framework

This study was conducted according to the standards for Good Clinical Practice, the fundamental ethical principles established in the Declaration of Helsinki and the Oviedo Convention, and the requirements of Spanish legislation in the research field. This study was approved by the local Institutional Review Board at each center. Written informed consent was obtained from all participants prior to randomization and inclusion in the study. Virtual visits were conducted using preferred local software for centralized messaging and voice-over-internet, complying with local laws and regulations. Communication protection during the virtual visits was ensured via compliance with each center's institutional and national requirements. Data were collected using the REDCap online database and an Excel database backup.

Procedure

For in-office visits: at baseline, we collected sociodemographic characteristics, such as age, gender, years of education, living status (urban/rural), social status (married, single, etc), PD duration, and PD treatments. Levodopa-equivalent daily dose (LEDD) and dopamine agonist–equivalent daily dose were calculated based on the literature at each visit.[12] We administered the clinical rating scales, performed comprehensive physical and neurological examinations, and made therapeutic adjustments and referrals based on the patient's clinical severity.

TM visits were conducted using videoconferences with mobile technology as the most common technical resource for patients and doctors. For videoconferences in Spain, Saudi Arabia, Nigeria, Uruguay, and Egypt, we used WhatsApp (Meta Platforms, Inc., Menlo Park, CA, USA) and Facetime. In South Korea, we used the Korean version of KakaoTalk (Kakao Corporation). In the TM visits, the neurologists performed an adapted neurological examination and performed therapeutic adjustments and referrals as needed. We concluded the TM visit with the administration of the Telemedicine Usability Questionnaire (TUQ), which assessed effectiveness, reliability, willingness to revisit, and satisfaction at each virtual visit.[13] In case of technical problems, backup solutions included phone calls, text messages, emails, and videos.

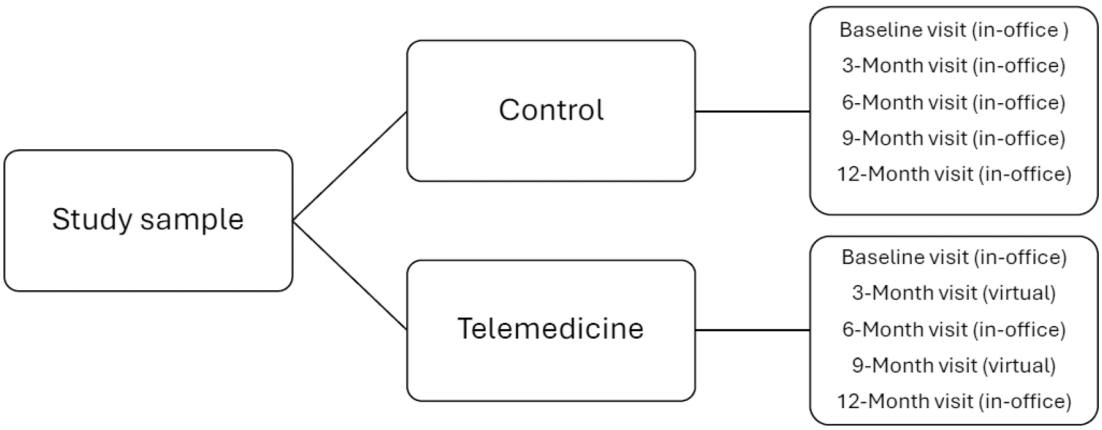

Fig. 1. Study design.

Assessments

Baseline sociodemographic information was obtained from medical records. Baseline clinical information included Hoehn & Yahr stage (HY)[14], LEDD, and cognitive status based on the Montreal Cognitive Assessment score (MOCA), with higher scores reporting better cognitive status.[15] Baseline and follow-up clinical management information was gathered at TM or in-office visits, including the number of adjustments and prescription of pharmacological and nonpharmacological treatments. Clinical assessments gathered at each in-office visit included health-related patient quality of life (QoL) using the Parkinson Disease Questionnaire-39 items (PDQ-39),[16] PD severity using the MDS-Unified PD Rating Scale (UPDRS),[17] and caregiver burden using the Zaritt caregiver burden index questionnaire (if the caregiver was available), with higher scores reporting worse status.[18] Satisfaction after in-office and TM visits was measured using a visual analog scale from 1 (very unsatisfied) to 5 (very satisfied).[13]

Analysis

The sample size was calculated using the *Practical Utility outcome* using a noninferiority approach. Assuming that the number of therapeutic recommendations per visit can range from 0 to 3, with an average number of 10 ± 1.95 therapeutic recommendations per year in 5 visits in the control group (T1), and 8 ± 1.95 in the study group (T2), similar clinical management was defined as a mean difference <3 (T1–T2), one-tailed test (H0: T1 = T2 + e; H1: T1 < T2 + e) (e = maximum difference of the means). With a 95% confidence interval, a power of 80%, and a dropout of 10%, 50 patients per group were required, with a minimum total study sample of 100 patients (R Statistical package).

The primary outcome was *Practical Utility*, which was measured by analyzing differences between TM and in-office visits, using clinical rating scales and the sum of adjustments of (a) pharmacological and (b) total (pharmacological plus non-pharmacological treatment) changes at each visit. Satisfaction was measured using visual analog satisfaction scales for in-office and TM visits (patients and providers) and TUQ for TM visits. The secondary outcome was *feasibility*, which was measured in terms of (a) *adherence* (proportion of virtual and in-office visits completed), (b) *retention* (dropout rate for in-office and virtual visits), (c) *technical burden* (percentage of incomplete virtual visits), (d) *administrative burden*: average time needed to complete TM visits. Post hoc analyses included comparisons among country-specific centers.

Statistical Analysis

The normal distribution of continuous variables was analyzed using the Kolmogorov–Smirnov test. Data were summarized as means ± standard deviation (SD), median (interquartile ranges), or counts (percentages). Comparisons were performed based on the normal distribution of the data, using Student's *t* tests for normal distributed data, Mann-Whitney *U* and Kruskal-Wallis tests for non-normally distributed data, and χ^2 for dichotomic data, with Bonferroni's correction for multiple comparison tests. Data analyses were performed using *IBM-SPSS 29* and *R* software statistical packages.

We performed longitudinal analyses of the differences in the estimated marginal outcome means between the time points (interaction) in the TM and control groups after being adjusted for age and sex, using linear mixed models (lme4 library of R), taking the patient (ID) as random effects (random intercept) (rating scale score ~ group*time + age + gender) +(1|ID). The significance level was set at $\alpha = 0.05$, two-sided.

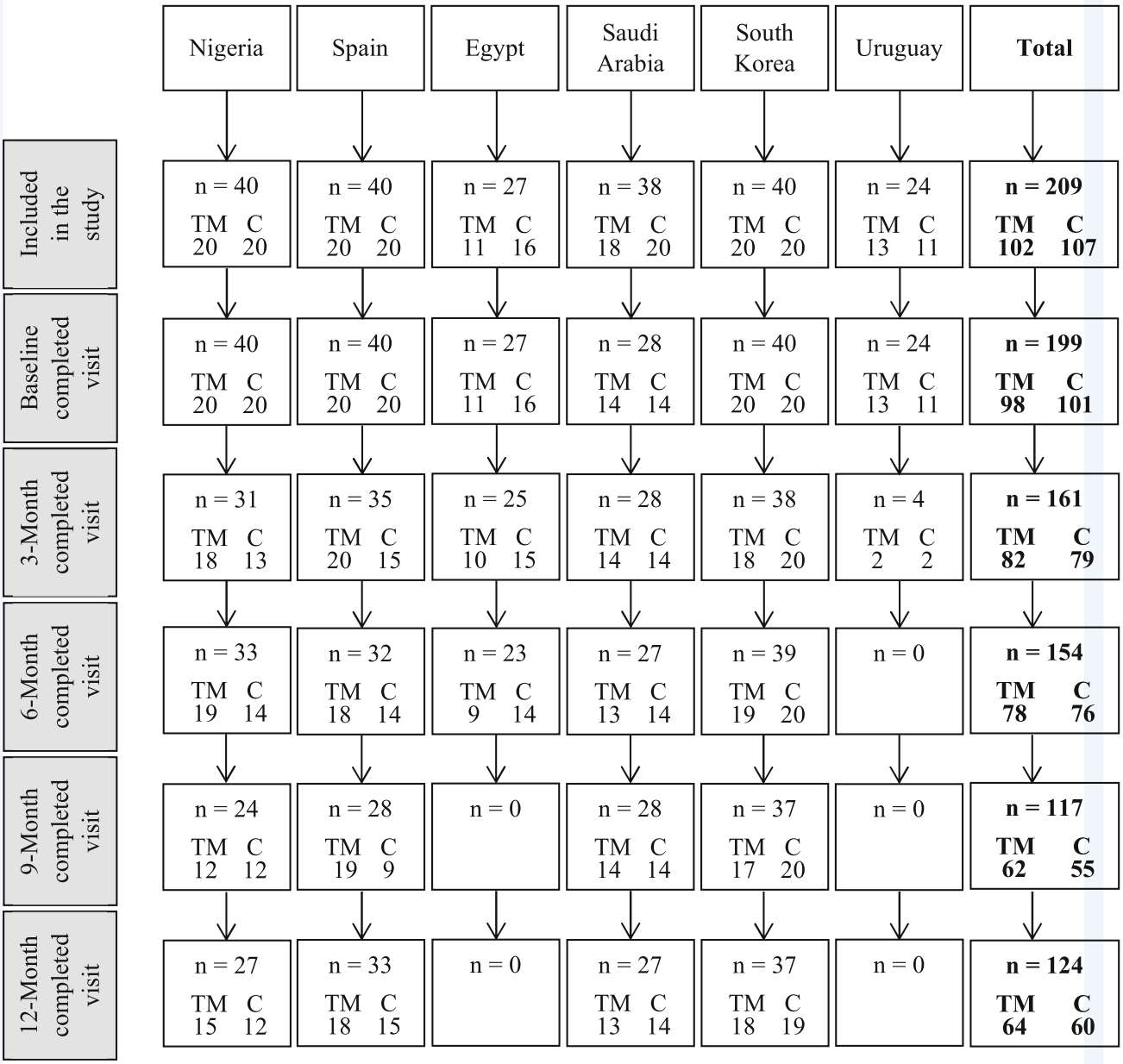

Fig. 2. Flowchart of participants. Legend: TM=Telemedicine; C=Controls

Results

Sample: We included 209 PD patients from 6 countries (40 [19.0%] from Nigeria, 40 [19.0%] from Spain, 38 [18.1%] from Saudi Arabia, 40 [19.0%] from South Korea, 27 [12.9%] from Egypt, and 24 [11.4%] from Uruguay) (Fig. 2), 59% of whom were male, with a mean age of 64.9 ± 12.2 years and a median HY stage of 2 (1–4). At baseline, PD patients from the TM and control groups were similar in terms of age, gender, education, civil status, PD duration, LEDD, use of advanced PD therapies, caregiver age, distance to the medical center, cognitive status and motor severity, except for a trend toward lower MDS-UPDRS Parts II and IV scores, and PDQ-39 scores in the TM group (Table 1).

Practical utility: The median number of pharmacological and total therapeutic changes was similar in both groups at each visit (Table 2). When we stratified these comparisons between countries, the pharmacological and total therapeutic changes were similar in both groups at 6 and 12 months ($P = > 0.10$)

TABLE 1 Baseline comparison between control and telemedicine groups

	Control group (N = 107)	Telemedicine group (N = 102)	*P*-value
Age, mean ± SD	65.09 ± 12.71	64.7 ± 11.71	0.81
Gender, n (%)			
Male	68 (64.0)	56 (55.0)	0.20
Female	39 (36.0)	46 (45.0)	
Education (in years), Median (IQR)	12 (6;15)	12 (8;15)	0.66
Civil status, n (%)			0.95
Married	75 (70.1)	73 (71.6)	
Single	5 (4.7)	5 (4.9)	
Widowed	20 (18.7)	23 (22.5)	
Divorced	6 (5.6)	1 (1.0)	
Other	1 (0.9)	0 (0.0)	
Living status, n (%)			0.54
With family	95 (88.8)	93 (91.2)	
Alone	11 (10.3)	8 (7.8)	
Caregiver	0 (0.0)	1 (1.0)	
Institutionalized	1 (0.9)	0 (0.0)	
PD duration (in years), median (IQR)	6 (4;10)	6 (3;9)	0.63
Working status, n (%)			0.63
Active employee	27 (25.2)	27 (26.5)	
Retired	51 (47.7)	51 (50.0)	
Sick leave	4 (3.7)	3 (2.9)	
Housewife	10 (9.4)	10 (9.8)	
Unemployed	4 (3.7)	7 (6.9)	
Other	4 (3.7)	3 (2.9)	
Not applicable	7 (6.6)	1 (1.0)	
Caregiver age, Median (IQR)*	58 (49;70)	54 (45;62)	0.20
Caregiver gender, n (%)			0.02
Male	38 (51.0)	23 (33.0)	
Female	36 (49.0)	47 (67.0)	
Caregiver education (in years), Median (IQR)	12 (10;16)	13 (11;16)	0.50
Distance to medical center (in km), median (IQR)	17 (4;55)	27 (5;78)	0.21
MoCA total score, Median (IQR)	25 (21;27)	26 (22;28)	0.22
MDS-UPDRS total score median (IQR)			
Part I	8 (4;16)	8 (5;14)	
Part II	12 (6;21)	9 (5;17)	
Part III	31 (17;49)	31 (13;45)	
Part IV	2 (0;8)	0 (0;5)	
PDQ-39 total score median (IQR)	37 (16;73)	24 (11;50)	0.02
Hoehn & Yahr stage	2 (2;3)	2 (1;2)	0.56

Abbreviations: SD, standard deviation; IQR, interquartile range; PD, Parkinson's disease; MoCA, Montreal Cognitive Assessment score; MDS-UPDRS, Movement Disorder Society Unified Parkinson's Disease Rating Scale; PDQ-39, Parkinson's Disease Questionnaire-39.
*Caregiver information data were available in 144 participants (74 from the control group and 70 from the telemedicine group).

TABLE 2 Follow-up comparison between control and telemedicine groups

	Baseline			3-Month			6-Month			9-Month			12-Month		
	Control group (n)	TM Group (n)	*P*-value	Control group (n)	TM group (n)	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value
LEDD (in mg), median (IQR)	750 (495;1.00) [98]	675 (400;1028) [89]	0.18	750 (500;950) [79]	750 (450;1183) [78]	0.73	750 (550;1000) [75]	750 (475;1250) [75]	0.85	750 (550;1013) [54]	750 (400;1205) [59]	0.50	750 (580;1000) [59]	750 (508;1250) [62]	0.88
Antidepressants, yes, n (%)	19 (18.81) [101]	16 (16.33) [98]	0.64	16 (20.25) [79]	12 (14.63) [82]	0.35	19 (25.00) [76]	10 (12.82) [78]	0.05	8 (14.55) [55]	12 (19.35) [62]	0.49	6 (10.00) [60]	11 (17.19) [64]	0.24
Anxiolytics, yes, n (%)	14 (13.86) [101]	6 (6.12) [98]	0.07	9 (11.39) [79]	6 (7.32) [82]	0.37	15 (19.74) [76]	5 (6.41) [78]	0.01	9 (16.36) [55]	4 (6.45) [62]	0.09	9 (15.00) [60]	6 (9.38) [64]	0.34
Antipsychotics, yes, n (%)	6 5.94 [101]	3 (3.06) [98]	0.5	3 (3.80) [79]	2 (2.44) [82]	0.68	4 (5.26) [76]	2 (2.56) [78]	0.44	2 (3.64) [55]	2 (3.23) [62]	1.00	2 (3.33) [60]	3 (4.69) [64]	1.00
DBS, yes, n (%)	4 (3.96) [101]	0 (0.0) [98]	0.12	3 (3.80) [79]	0 (0.0) [82]	0.12	3 (3.95) [76]	1 (1.28) [78]	0.36	1 (1.82) [55]	1 (1.61) [62]	1.00	2 (3.33) [60]	0 (0.0) [64]	0.23
Apomorphine-pump, yes, n (%)	1 (0.99) [101]	0 (0.0) [98]	1.00	2 (2.53) [79]	0 (0.0) [82]	0.24	1 (1.32) [76]	0 (0.0) [78]	0.49	0 (0.0) [55]	1 (1.61) [62]	1.00	0 (0.0) [60]	1 (1.56) [64]	1.00
Levodopa-gel pump, yes, n (%)	1 (0.99) [101]	2 (2.04) [98]	0.62	0 (0.0) [79]	2 (2.44) [82]	0.45	0 (0.0) [76]	3 (3.85) [78]	0.24	0 (0.0) [55]	2 (3.23) [62]	0.50	0 (0.0) [60]	2 (3.13) [64]	0.50
Physical therapy, yes, n (%)	17 (16.83) [101]	26 (26.53) [98]	0.12	17 (21.52) [79]	20 (24.39) [82]	0.67	17 (22.37) [76]	23 (29.49) [78]	0.31	18 (32.73) [55]	17 (27.42) [62]	0.53	16 (26.67) [60]	22 (34.38) [64]	0.35
Occupational therapy, yes, n (%)	3 (2.97) [101]	0 (0.0) [98]	0.25	3 (3.80) [79]	0 (0.0) [82]	0.12	1 (1.32) [76]	0 (0.0) [78]	0.49	5 (9.09) [55]	0 (0.0) [62]	0.02	3 (5.00) [60]	0 (0.0) [64]	0.11
Psychological support, yes, n (%)	2 (1.98) [101]	4 (4.08) [98]	0.44	1 (1.27) [79]	1 (1.22) [82]	1.00	1 (1.32) [76]	3 (3.85) [78]	0.62	3 (5.45) [55]	2 (3.23) [62]	0.66	3 (5.00) [60]	2 (3.13) [64]	0.67
Speech therapy, yes, n (%)	3 (2.97) [101]	1 (1.02) [98]	0.62	1 (1.27) [79]	0 (0.0) [82]	0.49	1 (1.32) [76]	0 (0.0) [78]	0.49	2 (3.64) [55]	1 (1.61) [62]	0.60	1 (1.67) [60]	0 (0.0) [64]	0.48
Nonpharmacological therapy changes, yes, n (%)	4 (3.96) [101]	3 (3.06) [98]	1.00	2 (2.53) [79]	4 (4.88) [82]	0.68	2 (2.63) [76]	3 (3.85) [78]	1.00	0 (0.0) [55]	1 (1.61) [62]	1.00	3 (5.00) [60]	3 (4.69) [64]	1.00
Pharmacological therapy changes, yes, n (%)	36 (35.64) [101]	28 (28.57) [98]	0.29	13 (16.46) [79]	21 (25.61) [82]	0.15	19 (25.00) [76]	18 (23.08) [78]	0.78	8 (14.55) [55]	15 (24.19) [62]	0.19	8 (13.33) [60]	14 (21.88) [64]	0.21
Therapeutic changes (number), median (IQR)	0 (0;0)	0 (0;1)	0.51	0 (0;0)	0 (0;0)	0.47	0 (0;0)	0 (0;1)	0.66	0 (0;0)	0 (0;1)	0.23	0 (0;0)	0 (0;0)	0.22
0, n (%)	60 (59.41)	64 (65.31)		64 (81.01)	63 (76.83)		54 (71.05)	58 (74.36)		46 (83.64)	46 (74.19)		52 (86.67)	49 (76.56)	
1, n (%)	27 (26.73)	19 (19.39)		13 (16.46)	14 (17.07)		15 (19.74)	14 (17.95)		6 (10.91)	12 (19.35)		4 (6.67)	15 (23.44)	
2, n (%)	11 (10.89)	13 (13.27)		1 (1.27)	4 (4.88)		7 (9.21)	4 (5.13)		3 (5.45)	3 (4.84)		3 (5.00)	0 (0.0)	
3, n (%)	1 (0.99)	1 (1.02)		1 (1.27)	1 (1.22)		0 (0.0)	2 (2.56)		0 (0.0)	1 (1.61)		1 (1.67)	0 (0.0)	
4, n (%)	2 (1.98) [101]	1 (1.02) [98]		0 (0.0) [79]	0 (0.0) [82]		0 (0.0) [76]	0 (0.0) [78]		0 (0.0) [55]	0 (0.0) [62]		0 (0.0) [60]	0 (0.0) [64]	
Physical therapy referral, yes, n (%)	23 (22.77) [101]	26 (26.53) [98]	0.54	12 (15.19) [79]	17 (20.73) [82]	0.36	16 (21.05) [76]	20 (25.64) [78]	0.50	15 (27.27) [55]	18 (29.03) [62]	0.83	15 (25.00) [60]	22 (34.38) [64]	0.25

(Continues)

TABLE 2 *Continued*

	Baseline			3-Month			6-Month			9-Month			12-Month		
	Control group (n)	TM Group (n)	*P*-value	Control group (n)	TM group (n)	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value
Occupational therapy referral, yes, n (%)	4 (3.96) [101]	2 (2.04) [98]	0.68	2 (2.53) [79]	1 (1.22) [82]	0.62	2 (2.63) [76]	0 (0.0) [78]	0.24	4 (7.27) [55]	0 (0.0) [62]	0.05	1 (1.67) [60]	0 (0.0) [64]	0.48
Psychological support referral, yes, n (%)	2 (1.98) [101]	0 (0.0) [98]	0.5	2 (2.53) [79]	0 (0.0) [82]	0.24	2 (2.63) [76]	1 (1.28) [78]	0.62	1 (1.82) [55]	0 (0.0) [62]	0.47	0 (0.0) [60]	2 (3.13) [64]	0.50
Speech therapy referral, yes, n (%)	6 (5.94) [101]	1 (1.02) [98]	0.12	1 (1.27) [79]	1 (1.22) [82]	1.00	2 (2.63) [76]	0 (0.0) [78]	0.24	1 (1.82) [55]	5 (8.06) [62]	0.21	0 (0.0) [60]	2 (3.13) [64]	0.50
Other nonpharmacological treatment referrals, yes, n (%)	4 (3.96) [101]	0 (0.0) [98]	0.12	5 (6.33) [79]	4 (4.88) [82]	0.74	1 (1.32) [76]	3 (3.85) [78]	0.62	0 (0.0) [55]	0 (0.0) [62]	1.00	0 (0.0) [60]	2 (3.13) [64	0.50
Internists referral, yes, n (%)	6 (5.94) [101]	5 (5.10) [98]	0.80	1 (1.27) [79]	0 (0.0) [82]	0.49	4 (5.26) [76]	1 (1.28) [78]	0.21	0 (0.0) [55]	0 (0.0) [62]	1.00	1 (1.67) [60]	0 (0.0) [64]	0.48
Psychiatrist referral, yes, n (%)	2 (1.98) [101]	5 (5.10) [98]	0.27	4 (5.06) [79]	6 (7.32) [82]	0.75	2 (2.63) [76]	0 (0.0) [78]	0.24	2 (3.64) [55]	0 (0.0) [62]	0.22	0 (0.0) [60]	1 (1.56) [64]	1.00
Psychologist referral, yes, n (%)	0 (0.0) [101]	0 (0.0) [98]	1.00	0 (0.0) [79]	0 (0.0) [82]	1.00	1 (1.32) [76]	0 (0.0) [78]	0.49	0 (0.0) [55]	0 (0.0) [62]	1.00	0 (0.0) [60]	0 (0.0) [64]	1.00
Primary care doctor referral, yes, n (%)	4 (3.96) [101]	7 (7.14) [98]	0.33	2 (2.53) [79]	1 (1.22) [82]	0.62	2 (2.63) [76]	2 (2.56) [78]	1.00	0 (0.0) [55]	0 (0.0) [62]	1.00	0 (0.0) [60]	0 (0.0) [64]	1.00
Other professional referral, yes, n (%)	5 (4.95) [101]	5 (5.10) [98]	1.00	4 (5.06) [79]	4 (4.88) [82]	1.00	5 (6.58) [76]	2 (2.56) [78]	0.27	4 (7.27) [55]	2 (3.23) [62]	0.42	3 (5.00) [60]	3 (4.69) [64]	1.00
MDS-UPDRS Part 1 total score, median (IQR)	8 (4;16) [101]	8 (5;14) [98]	0.47	N.A.	N.A.	N.A.	9 (5;15) [76]	7 (4;13) [78]	0.14	N.A.	N.A.	N.A.	8 (4;18) [58]	6 (3;11) [62]	0.27
MDS-UPDRS Part 2 total score, median (IQR)	12 (6;21) [101]	9 (5;17) [98]	0.09	N.A.	N.A.	N.A.	12 (4;22) [76]	9 (3;18) [78]	0.10	N.A.	N.A.	N.A.	13 (4;25) [58]	10 (4;15) [62]	0.25
MDS-UPDRS Part 3 total score, median (IQR)	31 (17;49) [101]	31 (13;45) [98]	0.28	N.A.	N.A.	N.A.	30 (15;59) [76]	27 (13;46) [78]	0.47	N.A.	N.A.	N.A.	27 (13;50) [58]	27 (11;48) [62]	0.84
MDS-UPDRS Part 4 total score, median (IQR)	2 (0;8) [101]	0 (0;5) [98]	0.07	N.A.	N.A.	N.A.	2 (0;9) [76]	0 (0;6) [78]	0.05	N.A.	N.A.	N.A.	2 (0;7) [58]	1 (0;5) [62]	0.21
MDS-UPDRS total score, median (IQR)	56 (32;90) [101]	50 (26;72) [98]	0.14	N.A.	N.A.	N.A.	55 (28;97) [76]	43 (24;72) [78]	0.20	N.A.	N.A.	N.A.	49 (24;93) [58]	47 (22;72) [62]	0.50
PDQ-39 total score, median (IQR)	37 (16;73) [101]	24 (11;50) [98]	0.02	N.A.	N.A.	N.A.	37 (13;72) [76]	25 (7;52) [78]	0.06	N.A.	N.A.	N.A.	25 (10;79) [58]	19 (9;32) [62]	0.25
ZBI-12 total score, median (IQR)	9 (4;21) [42]	7 (0;24) [43]	0.32	N.A.	N.A.	N.A.	11 (4;28) [26]	16 (2;35) [21]	0.76	N.A.	N.A.	N.A.	12 (4;28) [19]	17 (6;45) [15]	0.18
TUQ, mean ± SD															
Usefulness					6.22 (0.81)						6.43 (0.61)				

(Continues)

TABLE 2 *Continued*

	Baseline			3-Month			6-Month			9-Month			12-Month		
	Control group (n)	TM Group (n)	*P*-value	Control group (n)	TM group (n)	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value	Control Group [*n*]	TM Group [*n*]	*P*-value
Ease of use and learnability					6.14 (1.28)						6.27 (1.00)				
Interface quality	N.A.	N.A.	N.A.	N.A.	5.94 (1.19)	N.A.	N.A.	N.A.	N.A.	N.A.	6.10 (1.10)	N.A.	N.A.	N.A.	N.A.
Interaction quality					6.15 (1.02)						6.22 (0.99)				
Reliability					5.11 (1.45)						5.53 (1.33)				
Satisfaction and future use					6.42 (0.88)						6.57 (0.69)				
Satisfaction, patient very satisfied, n (%)	80 (80.00) [100]	68 (72.34) [94]	0.08	55 (79.71) [69]	61 (75.31) [81]	0.74	50 (69.44) [72]	63 (84.00) [75]	0.08	42 (76.36) [55]	47 (75.81) [62]	0.95	51 (87.93) [58]	55 (88.71) [62]	0.57
Satisfaction, doctor very satisfied, n (%)	78 (78.00) [100]	72 (76.60) [94]	0.99	54 (78.26) [69]	56 (69.14) [81]	0.18	47 (64.38) [73]	60 (81.08) [74]	0.03	35 (63.64) [55]	37 (59.6) [62]	0.26	40 (68.97) [58]	49 (79.03) [62]	0.03
Completed visits, n (%)	101 (94.39) [107]	98 (96.07) [102]	0.75	79 (73.83) [107]	82 (80.39) [102]	0.26	76 (71.03) [107]	78 (76.47) [102]	0.37	55 (51.89) [107]	62 (61.39) [102]	0.17	60 (65.93) [107]	64 (70.33) [102]	0.52

Note: Bonferroni's *P*-value corrections were applied ($P = 0.001$).

Abbreviations: LEDD, levodopa-equivalent daily dose; IQR, interquartile range; DBS, deep brain stimulation; MDS-UPDRS, Movement Disorder Society Unified Parkinson's Disease Rating Scale; N.A, not applied; PD, Parkinson's disease; PDQ-39, Parkinson's Disease Questionnaire-39; TUQ, Telemedicine Usability Questionnaire; SD, standard deviation.

(Tables S1–S12). Compared to the TM group, there was a higher number of phone calls: 2.00 (1.75;3.00) versus 1.00 (1.00;1.00), $P < 0.0001$, at 6 months, in the in-office visits: 1.00 (0.00;1.00) versus 0.00 (0.00; 0.00), $P < 0.0001$, at 12 months in the control group, and on the contrary, higher number of in-office visits in the TM group compared to the control group: 3.50 (2.00;3.50) versus 1.00 (1.00;1.00), $P < 0.0001$, at 6 months. In univariate comparison analyses, MDS-UPDRS scores and Zaritt caregiver burden index were similar between the TM and control groups, with similar results in different countries (Tables 2 and S1–S12). Overall, in multivariate linear mixed models, at 6 and 12-month follow-up visits, there were no significant differences in the total MDS-UPDRS ($P = 0.94$), PDQ-39 ($P = 0.44$), and Zaritt caregiver burden index scores ($P = 0.86$) between the TM and control groups. TUQ scores were similar at 3 and 9 months in the TM group, with an overall similar high rate of satisfaction in both visits (Tables 2 and S1–S12), but doctor's higher satisfaction at 6 and 12-month visits in the TM group.

Feasibility: After they signed the informed consent form, 199 (95.2%) patients were included at baseline, 107 patients (51.19%) were allocated to the control group, and 102 patients (48.80%) to the TM group. In follow-up, 154 patients (49.35% from the control group and 50.64% from the TM group) were evaluated at 6 months, and 124 (48.38% from the control group and 51.61% from the TM group) at 12 months, with similar dropout rate at 6 and 12 months ($P = 0.16$ and 0.52, respectively) (Table 2). The most frequent reasons for dropouts at 3, 6, 9, and 12-month visits were comorbidities (16.7%, 24.0%, 13.9%, and 14.8%, respectively), not being interested (16.7%, 8%, 27.8%, and 18.5%, respectively), which were similarly distributed in both groups ($P > 0.05$), and technology limitations (4.2% and 5.6% at 3- and 9-month visits) in the TM group. Overall, the percentage of PD patients living with family and longer distances from the medical center was higher in the group of patients who completed the study 12 months later ($P < 0.0001$).

Only for TM visits, at 3 months, the videoconferences were completed with the patient (86.8%), spouse (2.6%), son/daughter (2.6%), and caregiver (7.9%) and lasted a median of 16 (10;20) minutes. At 9 months, the videoconferences were completed with the patient (82.8%), with the son/daughter (15.5%), and the caregiver (1.7%), and lasted a median of 15 (10;20) minutes.

When we stratified the results based on participating countries, the mean percentage of completed visits between the different countries were different at 3 months: 78% in Nigeria, 88% in Spain, 93% in Egypt, 74% in Saudi Arabia, 95% in South Korea, and 17% in Uruguay ($P < 0.0001$); at 6 months: 83% in Nigeria, 85% in Spain, 85% in Egypt, 71% in Saudi Arabia, 98% in South Korea, and 0% in Uruguay ($P < 0.001$); at 9 months: 60% in Nigeria, 70% in Spain, 100% in Egypt, 74% in Saudi Arabia, 93% in South Korea, 0% in Uruguay (P<0.0001) ; and at 12 months: 68% in Nigeria, 83% in Spain, 71% in Saudi Arabia, 93% in South Korea and 0% in Egypt and Uruguay ($P < 0.0001$) (Tables S1–S12).

Discussion

In this study, we provide evidence with relatively long longitudinal data regarding the use of TM for PD as an adjunctive tool for in-office visits resembling real-world practice across different geographic regions. The comparable dropout rates between TM and in-person visits suggest that TM can be feasibly integrated into routine care.

These findings have implications beyond the specific centers involved in the study. Our findings suggest that TM can be a viable strategy for PD, providing a similar management compared to in-office visits, and might encourage health professionals and healthcare administrators to adopt, particularly in systems where policymakers remain hesitant due to a lack of prior practical evidence, and require a minimum number of in-office visits per year.[19] Moreover, the study design, excluding TM for initial diagnosis and focusing on follow-up care, mirrors common clinical workflows, enhancing the relevance and transferability of the findings to other contexts, including multidisciplinary care for PD.[20,21]

Regarding usability and satisfaction for TM, the management in-between visits were different but not clinically relevant, and patients were equally satisfied with slightly lower scores in the reliability domain, indicating difficulties in recovering the connection when there is a technical problem. Interestingly, doctors had a trend for higher satisfaction at 6 and 12-month visits, suggesting that doctors prefer in-person visits after using TM visits, in contrast to patients, where no differences were observed.

The way videoconferences are conducted and the specific features of the platform used may pose limitations in certain settings, particularly regarding data security. Previous research on TM for neurological disorders supports the potential of using messenger apps, such as WhatsApp and other similar freeware applications, to communicate effectively, enhancing patient engagement and accessibility in managing chronic diseases.[22] One of the primary advantages of implementing widely used freeware applications, with an intuitive interface requiring minimal technical training, is that they are particularly valuable for older PD patients, with limited familiarity with complex telemedicine platforms.[23] Additionally, caregivers and family members can participate and assist the patients in these virtual interactions, ensuring a more comprehensive and inclusive approach to disease management. These freeware applications require minimal infrastructure investment and offer free or low-cost communication options. This aspect is particularly advantageous in resource-limited settings where access to healthcare facilities or advanced TM platforms may be constrained.

Despite the benefits of using freeware applications for PD TM care, there are notable limitations. We have included patients with access to a stable Internet connection and a smartphone. These requirements may pose barriers for some patients, particularly for elderly patients and those with speech problems, or living in rural or economically disadvantaged areas. Addressing this digital divide is essential to ensure equitable access to telehealth services.[24] Another concern is patient privacy and data security when using freeware applications. Although WhatsApp and similar applications employ end-to-end encryption, their use raises questions about compliance with healthcare privacy regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in Europe.[25] In this regard, we systematically reviewed the articles/websites about videoconferencing software in a previous study, determining technical capabilities and basic security features.[22] Surprisingly, we found incomplete data regarding capability and security for different videoconferencing software platforms, suggesting that information about technical capabilities and data security is not easily and openly accessible for interested future users.[22] Moreover, WhatsApp and other similar freeware applications are not specifically designed for medical use, which limits their functionality in certain aspects of PD care. For instance, the platform lacks integration with electronic health records or medical devices, making it challenging to document patient interactions or synchronize data from wearable devices that monitor motor symptoms or medication adherence. These limitations may hinder the ability of healthcare providers to deliver holistic and data-driven care.

The strength of our conclusions is tempered by some limitations. First, this is not a blinded study, and the sample size was calculated for the entire group, so stratification and interpretation of the data by country may be underpowered and at risk of a type 2 statistical error. Second, we included participants with mild–moderate PD with a mean age of 65 years, without significant cognitive impairment, from movement disorders units with highly specialized neurologists, and with Internet access, and the support of a caregiver/relative if needed. There is no doubt that the characteristics of our sample limit the extrapolation of our data to the global PD community. Third, different factors could explain the lack of follow-up in specific centers. This is a research protocol, with the burden associated with the additional paperwork, documentation, and research procedures. The lack of follow-up in certain centers was not specific to TM and, therefore, does not reflect the feasibility of TM. It could have been similarly observed if this was an entirely different research study. Fourth, regarding visit time consumption, we only completed information with the TM visits, missing the comparison with in-office visits. Fifth, the results of this study cannot be extrapolated to the urgent medical care needs and coverage of PD patients using TM, which depends on the country-specific health system characteristics, and legal frameworks, limiting its use or making it financially challenging.

In conclusion, direct-to-home videoconferencing consultations with commercially available messenger apps present a viable, practical, and scalable telehealth solution for managing PD globally. The role of technology in reducing geographical and logistical barriers to care is particularly noteworthy, making it a promising tool for resource-limited settings. However, addressing its limitations, including concerns around privacy, digital accessibility, and functionality, is critical to fully realizing its potential. Future research should explore ways to integrate the TM platforms with other healthcare technologies for long-term PD management.

Author Roles

(1) Research project: A. Conception, B. Organization, C. Execution; (2) Statistical analysis: A. Design, B. Execution,

C. Review and critique; (3) Manuscript preparation: A. Writing of the first draft, B. Review and critique.

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Disclosures

Ethical Compliance Statement: This study was approved by the local Institutional Review Boards at each local center. We confirm that we have read the journal's position on issues involved in ethical publication and affirm that this work is consistent with those guidelines. All patients signed the informed consent form before participating in this study.

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Data Availability Statement

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

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Supporting Information

Supporting information may be found in the online version of this article.

Supplementary Table S1. Baseline comparison between the control and telemedicine groups in Nigeria.

Supplementary Table S2. Follow-up comparison between the control and telemedicine groups in Nigeria.

Supplementary Table S3. Baseline comparison between the control and telemedicine groups in Spain.

Supplementary Table S4. Follow-up comparison between the control and telemedicine groups in Spain.

Supplementary Table S5. Baseline comparison between the control and telemedicine groups in Egypt.

Supplementary Table S6. Follow-up comparison between the Egyptian control and telemedicine groups.

Supplementary Table S7. Baseline comparison between the control and telemedicine groups in Saudi Arabia.

Supplementary Table S8. Follow-up comparison between the control and telemedicine groups in Saudi Arabia.

Supplementary Table S9. Baseline comparison between the control and telemedicine groups in South Korea.

Supplementary Table S10. Follow-up comparison between the control and telemedicine groups in South Korea.

Supplementary Table S11. Baseline comparison between the control and telemedicine groups in Uruguay.

Supplementary Table S12. Follow-up comparison between the control and telemedicine groups in Uruguay.