

# Acceptability and practicability of self-management for patients with Parkinson's disease based on smartphone applications in China

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# Abstract

Background China has had about 1.2 billion mobile-phone users and the usage has been still growing, however, mobile-health(m-Health) services are currently in the initial stage and have not yet prevailed. Additionally, the prevalence of Parkinson's disease (PD) is 190/100,000 in China, and patients need m-Health to manage their PD. Therefore, this study was designed to determine the attitudes and practicability towards about smartphone applications (APPs) of self-management of chronic condition among the elderly with PD in China. Methods Total 204 participants with PD were selected, from 52 to 87 years, and conducted by attitude surveys concerning using APPs for managing chronic condition via questionnaires. Results Among the total participants, 65.19% subjects had smartphones, and 82.84% ones preferred to use APPs for PD management, who were younger and more frequent web users with higher education standards and better medication compliance as well as longer PD courses and worse conditions of PD, compared with the rest of subjects(  $P < 0.001$ ,  $P = 0.001$ ,  $P < 0.001$ ,  $P = 0.041$ ,  $P < 0.001$ ,  $P = 0.013$ . Additionally, the preference of patients for the use of the APPs is positively related to education standards(  $P < 0.001$ ), while negatively related to age and PD course (  $P = 0.017$ ,  $P < 0.001$ ). Conclusion Patients with PD are positive about self-management of smartphone APPs in China. Consequently, improving the coverage of smartphones developing practical and handy APPs would become a novel and promising strategy for PD self-management.

## Background

Parkinson's disease (PD) is a progressive, neurological disorder associated with degeneration of the dopamine-producing cells in the nigra [1]. In 2005, there were about 2 million PD patients in China, which will reach 5 million in 2030[2]. The cardinal features of PD are bradykinesia, tremor, rigidity and postural instability[3]. Once suffering from PD, patients were disturbed by the motor symptoms of PD in daily functions, activities and roles[4]. Although the pathological mechanism and treatment strategy of PD have been significantly progressed in recent years, there is still no effective treatment. Recent studies have indicated that smartphone APPs have potential for offering automated and customized support for medication compliance to individuals with chronic diseases conditions[5]. Recently, a variety of APPs have been developed and successfully applied to effective self-management of patients with hypertension, diabetes and other chronic diseases[6-10]. And PD management APPs or Net have been used in developed countries such as Holland and Swedish[11, 12]. Thereby, self-management is considered as one of the most effective measures to help improve their medication compliance for patients with PD and control clinical symptoms as well as weaken the adverse effects of this disease[11, 13].

Meanwhile, China has had about 1.2 billion cell-phone users and the usage has been still growing[14], however, mobile health services are currently in the initial stage and have not yet prevailed. The key to obtaining the success of any APPs is catering for the willingness of targeted individuals and getting their acceptance as well as facilitating their use of the technologies[15, 16]. Thus, the purpose of our research was to investigate the acceptability and practicability of using APPs for PD self-management in China.

## Methods

### Subjects and interview

All Parkinson's patients were recruited from the Parkinson Clinic of the Second Affiliated Hospital of Chongqing Medical University. Parkinson's patients were examined by at least two experienced neurologists. In our study, Parkinson's disease was determined according to the diagnosis of PD and exclusionary criteria[17]. And all participants were able to read, or write, or understand what they were asked for so that they have the ability to complete the questionnaire. Also, investigators were trained rigorously in study methodology, then they subsequently interviewed all target patients. This study was approved by the Research Ethics Committee of the Second Affiliated Hospital of Chongqing Medical University. And each patient signed a consent form when enrolled in the study.

### Content of questionnaire

The questionnaire consists of Part I, Part II, Part III and Part IV. Part I is used to inquire patients' characteristics, including demographic data (ages, gender, educational level, occupation) and the main clinical features of PD (disease course of PD, number of anti-PD drugs, Movement Disorder Society-Unified Parkinson's disease rating scale (MDS-UPDRS), Hoehn & Yahr Stage (H & Y)). Part II aims for surveying the number of patients who have mobile phones and the ways they used to obtain general information about PD, also, investigating the preference of patients with PD that smartphone APPs can push. According to a previous related survey, these content mainly contains general information about PD (symptoms, pathophysiology, epidemiology and prognosis), doctors' interaction with patients and their regular answers for patients' questions via Internet, primary medication advice about medication types, new medicine and side effects, symptoms recorded as video and written recordings of the motor symptoms and non-motor symptoms of PD, PD education for suitable rehabilitating exercises, positive outlook and adverse factors to be avoided such as missed medication, accidental fall, emotional disorder or sleep deprivation. Part III is mainly applied to evaluate

medication adherence. An modified Morisky Medication Adherence Scale (MMAS-8) have good test-retest reliability (intraclass correlation coefficient = 0.729) and moderate internal consistency (Cronbach's  $\alpha$  = 0.556) [18-20]. And seven out of eight items (from items 1 to 7) need to be answered "yes/no", in which a 'no' score 1 point, and a 'yes' score 0 points. While item 8 was measured on a five-point Likert scale, in which responses of 'never', 'once in a while', 'sometimes', 'usually', and 'all the time' were respectively scored as 1, 0.75, 0.50, 0.25, and 0, respectively[18]. Part IV is composed of a 10-item questionnaire concerning the assessment of the attitudes of the use of APPs for-self-managing PD. And these items were answered via using a 5-point Likert type scale with 5 being 'strongly agree', 3 being 'neutral' and 1 being 'strongly disagree', which has been improved from previous studies based on the use of APPs for chronic disease management in patients with chronic diseases such as epilepsy, obesity testing and daily medical car.

## Statistical analysis

SPSS 25.0 software was used for statistical analysis. The demographics and clinical characteristics of all patients by means  $\pm$  standard deviations (means  $\pm$  SD) for continuous variables and by frequency distributions for categorical variables. The clinical and demographic features of attitude groups were analyzed using a Student's test for continuous variables, Pearson  $X^2$  test for categorical variables and Spearman correlation analysis.

## Results

### Demographics and clinical characteristics

A total of 208 patients were asked whether they would like to participate in the survey, then 204 participants (115 male and 89 female) agreed to do it, from January 2017 to May 2018. The average age of participants in our samples was  $68.75 \pm 9.54$  years (ranged from 52 to 87 years). The number of patients who lived in cities and rural areas are 172 (84.31%) and 32 (15.69%) respectively. The mean education level of participants in our samples was  $5.20 \pm 3.14$  years [from 1 year to 15 years]. In addition, 71.08% of patients could control PD by using less than two types of anti-Parkinson drugs. The mean Morisky Scale score was  $5.75 \pm 1.45$ . The demographic details of the patients are given in Table 1.

Table 1 Sociodemographic and Parkinson's disease-related clinical characteristics of surveyed participants.

Variable	No.	%
Age (years)		
<i>≤60</i>	46	22.55
<i>61-70</i>	84	41.76
<i>≥71</i>	74	36.27
Gender		
<i>Male</i>	115	56.37
<i>Female</i>	89	43.63
Resident location		
<i>Urban</i>	172	84.31
<i>Rural</i>	32	15.69
Education level		
<i>≤6</i>	39	19.12
<i>7-12</i>	127	62.25
<i>≥13</i>	38	18.63
Occupation (employment)		
<i>self-employed</i>	32	15.69
<i>Stable work or retirees</i>	172	84.31
Number of anti-PD drug		
<i>≤two drugs</i>	145	71.08
<i>≥three drugs</i>	59	28.92
PD course		
<i>≤5</i>	133	65.20
<i>≥6</i>	71	34.80
MDS-UPDRS [Hoehn & Yahr Grade]		
<i>≤50 [ ]</i>	115	56.37
<i>51-100 [ ]</i>	89	43.63

## Mobile phone possession and ways of obtaining PD information

Almost all repliers (96.08%, 196/204) had their own cell phones and most patients (65.19%, 133/204) claimed possession of smartphones and access to smartphones among households. According to our survey, 50.00% (102/204) of patients browsed the web, and 20.59% (21/102) of them preferred to use computers while 79.41% (81/102) of them preferred to use smartphones. Respondents claimed that their main sources of PD information were from clinic doctors (100%, 204/204), via a doctor and smartphone (15.20%, 31/204), or other media (7.43%, 16/204) (Fig. 1).

**Fig. 1** The methods of obtaining Parkinson's disease information

## Willingness and attitudes towards the use of PD self-management APPs

Only 8.82% (18/204) of participants had learned about information of APPs for managing chronic diseases such as diabetes mellitus or hypertension. More than half of the surveyed patients replied that they would use APPs for PD self-management if they were provided for free and were useful and easy to operate, could remind taking medication on time, protect privacy and reduce economical and psychological burden (Table 2). Most importantly, participants had a more positive attitude toward using PD self-management APPs, if easy to operate.

Table 2 The survey results of reaction to the Parkinson disease management apps for related patients

Survey items	SA + A N (%)	N N (%)	SDA + DA N (%)
I would use it, if it were free.	136	47	21
	66.67	23.04	10.29
I would try it out, if it were easy to operate.	169	20	15
	82.84	9.81	7.35
I would use it, if it allowed doctor to make medication change quicker.	145	41	18
	71.09	20.09	8.82
I would use it, if it protected my privacy.	139	22	43
	68.14	10.78	21.08
I thought it would solve the questions related to Parkinson's disease.	124	66	14
	60.78	32.35	6.86
I thought it would help remind me to follow doctors' directions.	150	32	22
	73.53	15.69	10.78
I thought it would reduce the psychological burden of Parkinson's disease.	160	26	23
	75.98	12.75	11.27
I thought it would reduce the frequency of seeking medical advice and the costs.	148	37	19
	72.55	18.14	9.31
I believed it would be helpful for me to communicate with doctor.	151	18	37
	73.04	8.82	18.14
I thought it would be useful to manage my Parkinson's disease.	141	63	3
	67.65	30.88	1.47

SA, strongly agree; A, agree; N, neutral; SDA, strongly disagree; D, disagree; SD, standard deviation.

## Participants' interests in contents of smartphone APPs for PD management

Participants' interests in contents of smartphone APPs for PD self-management showed in Fig. 2. The percentages of patients interested in general PD information,

interacting with doctor online, medication advice, symptoms recording and, Parkinson's disease education were 60.29%, 77.46%, 54.90%, 65.69% and 80.88%, respectively.

**Fig. 2** Participants' interests in contents of smartphone APPs for PD self-management

### Characteristics of respondents with positive attitudes to using APPs

To weigh up which characteristic of patients distinguishes potential users better, correlations between every item related to patients and their attitudes towards smartphone APPs were analyzed. We chose the survey item "I would try it out, if it were easy to operate." to be measured, which is the key point concerning patients' benefits. Sociodemographic and clinical characteristics of participants were analyzed in Table 3. Among these patients, those who were more tend to use APPs were those who were younger, had higher education, had good medication adherence, browsed the web, had longer PD course and had worse conditions of PD [ $P < 0.001$ ,  $P = 0.001$ ,  $P < 0.001$ ,  $P = 0.041$ ,  $P < 0.001$ ,  $P = 0.01$ ]. There were no statistically differences between women and men ( $P = 0.517$ ), resident location (urban and rural,  $P = 0.795$ ), occupation (self-employer and stable work or retirees,  $P = 0.478$ ) or drug intake number (no more than 2 and no less than 3 anti-PD drugs,  $P = 0.162$ ) with respect to whether patients were glad to use it or not.

Table 3 Sociodemographic and clinical characteristics of survey patients who would like to use a Parkinson's disease self-management app, if it were easy to operate.

Variable	SA + A	N + SD + D	<i>P</i>
Age (years)	67.05±9.24	76.14±9.76	<0.001
Education level	10.81±3.23	8.83±3.26	0.001
Morisky Scale score	5.91±1.41	4.94±1.39	<0.001
Gender			0.517
Male/Female	97/72	18/17	
Resident location			0.795
<i>Urban</i>	143(84.6%)	29(82.9%)	
<i>Rural</i>	26(15.4%)	6(17.1%)	
Occupation (employment)			0.478
<i>self-employed</i>	57(33.7%)	14(40.0%)	
<i>Retirees</i>	112(66.3%)	21(60.0%)	
Number of anti-Parkinson drug			0.162
<i>≤two drugs</i>	123[72.8%]	22[61.1%]	
<i>≥three drugs</i>	46[27.2%]	14[38.9%]	
Whether browsing a web			0.041
<i>Browsing</i>	90[53.3%]	12[34.3%]	
<i>Not browsing</i>	79[46.7%]	23[65.7%]	
Parkinson disease course			<0.001
<i>≤5 years</i>	121[71.6%]	12[36.4%]	
<i>≥6 years</i>	48[28.4%]	21[63.6%]	
MDS-UPDRS[H & Y]			0.013
<i>≤50[ ]</i>	87(51.5%)	26(74.3%)	
<i>51-100[ ]</i>	82(48.5%)	9(25.7%)	

To further investigate the correlation between the characteristics of the above-discussed patients and APP acceptance, we performed a correlation analysis. The results suggest that the willingness to use APPs of patients to management PD is positively related to education level ( $P < 0.001$ ). However, the age and PD course are negatively correlated with it ( $P = 0.017$ ,  $P < 0.001$ ), and MDS-UPDRS is uncorrelated ( $P = 0.924$ ). Results are shown in Table 4.

Table 4 Correlation analysis between Sociodemographic and clinical characteristics of survey patients and APP acceptance

	correlation coefficient	<i>P</i>
Age	-2.56	< 0.001
Education level	0.167	0.017
MDS-UPDRS	0.007	0.924
Parkinson disease course	-2.76	< 0.001

## Discussion

To our knowledge, this is an infrequency and significant study on practicability and acceptability of smartphone APPs for PD self-management among the elderly. This study investigated the willingness of Parkinson's patients (primarily the elders) from various backgrounds using self-management APPs. Although the smartphone usage levels of the old have been still lower than of the younger, the aged would prefer to manage PD through the exclusive APPs. Therefore, using APPs for Parkinson's self-management is feasible.

In our study, 96.08% participants (196/204) owned mobile phones, and 67.35% ones (133/196) owned smartphones[21]. There are substantial patients using smartphones, but a few ones searching for PD information through their phones. Furthermore, m-Health and electronic health (e-Health) APPs for self-management of chronic disease both have been rapidly developed[7, 22], however, most patients still acquire information about PD by asking doctors at clinic in China. And few patients with PD had knowledge of smartphone APPs for self-management before being surveyed[23, 24]. Thus, the present study shows that the number of Parkinson's patients using smart phones is less than of the previous study[16]which may result from the perception and acceptance of the elders, who are vulnerable to PD, being lower. Therefore, in terms of older Parkinson's patients, the popularity of smartphones needs to be further boosted.

In regards to the content of smartphone APPs of PD self-management, patients are eager to gain access to Parkinson's disease education, recording their symptoms and communicating about their condition with doctor online by the APPs. And the appeals for the content of APPs can exactly reveal that there are shortage of general PD information, related medical education and communication with doctors in China. Furthermore, patients are in urgent need of the APP that can record both motor and non-motor symptoms to manage PD better. These may be just what Chinese Parkinson's patients need urgently.

Compared with the older participants, the younger, who are more tend to use the APPs for self-management, are more frequent web users with higher education standards and better medication compliance as well as longer PD courses and worse conditions of PD. And the reason why younger patients and the ones with higher education were more inclined to use the APPs may be that their perception and acceptance of smart devices can be higher. Namely, participants who often browse the web may have positive attitudes toward using the APPs because they are more familiar with Internet and could accept new things more easily. And the ones with longer PD courses and worse conditions of PD may prefer to use the APPs due to their need of professional platforms where they can get advice on how to manage and control PD. The finding was consistent with previous study of patients with epilepsy[25], but in contrast to the study of evaluating kidney transplant patients attitudes about using m-Health technology for managing and monitoring medication therapy, which indicates poor medication compliance or severe medication side effects have not an influence on patient's attitude to use m-Health[26]. Contradictorily, in our survey, patients with poor medication adherence were more likely to use APPs—to some extent, on account of their need of being supervised more conveniently in health care and having better access to the guidance of specialists via the exclusive Apps.

The study still has several limitations. Firstly, all patients with PD were recruited from a single location. In the future, a multi-center and large-sample experimental study will be supposed to be conducted. Secondly, this study investigated patients' attitudes toward smartphone APPs for PD self-management, without the feedback on the progress of use of the Apps in practice. Nonetheless, we have tried our best to apply the APPs to the management of patients with PD, and the technology would be supposed to be improved continuously.

## Conclusions

The results indicated that a certain number of Parkinson's patients had already owned smartphones. Meanwhile, the study demonstrated that there was a positive attitude toward smartphone APPs for patients. Consequently, improving smartphones

usage levels as well as developing practical and handy APPs would become a promising strategy for PD self-management.

## Abbreviations

**m-Health:** mobile-health

**e-Health:** electronic-health

**SD:** standard deviations

**APPs:** applications

**PD:** Parkinson's disease

**H & Y:** Hoehn & Yahr Stage

**MMAS:** Morisky Medication Adherence Scale

**MDS-UPDRS:** Movement Disorder Society-Unified Parkinson's disease rating scale

## Declarations

Ethics approval and consent to participate

A verbal consent was obtained from each study participant and approved by the Research Ethics Committee of the Second Affiliated Hospital of Chongqing Medical University (No. (2019) No. 268).

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

None.

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#### Authors' contributions

Jie Hu: Study design, data acquisition, statistical analysis, drafting of manuscript, and manuscript revision; Dezhi Yuan: Study design, data acquisition, statistical analysis, and significant review of the manuscript; Qiuye Zhao: Statistical analysis, and significant review of the manuscript; Xuefei Wang: Data acquisition, and interpretation of study findings; Xiaotian Zhang: Study design, and data acquisition; Qihui Jiang: Design of this study, and data acquisition; Huirong Luo: Drafting of manuscript, and manuscript revision; Jing Li: Study design and manuscript revision; Jianhua Ran: Study design, interpretation of study findings, and manuscript revision; Jinfang Li: Study design, interpretation of the study findings, and significant review of the manuscript. All authors reviewed the manuscript for intellectual content, approved the final version, and agreed to be accountable for the work.

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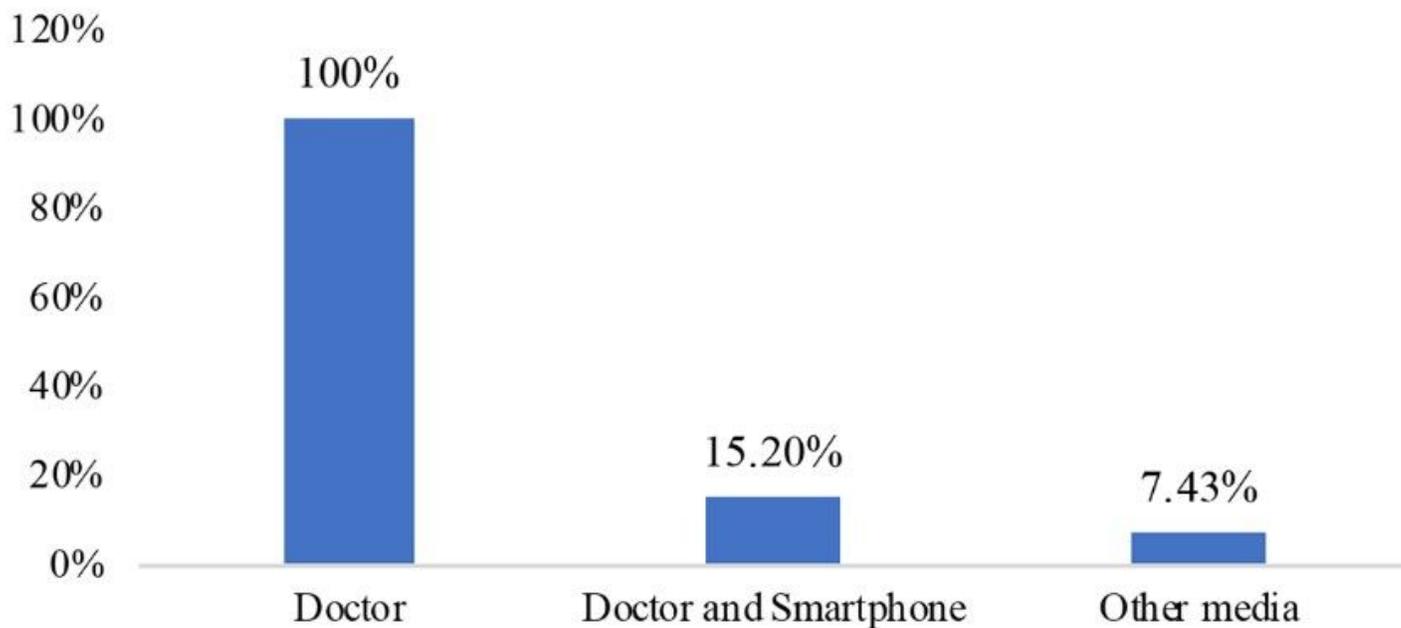
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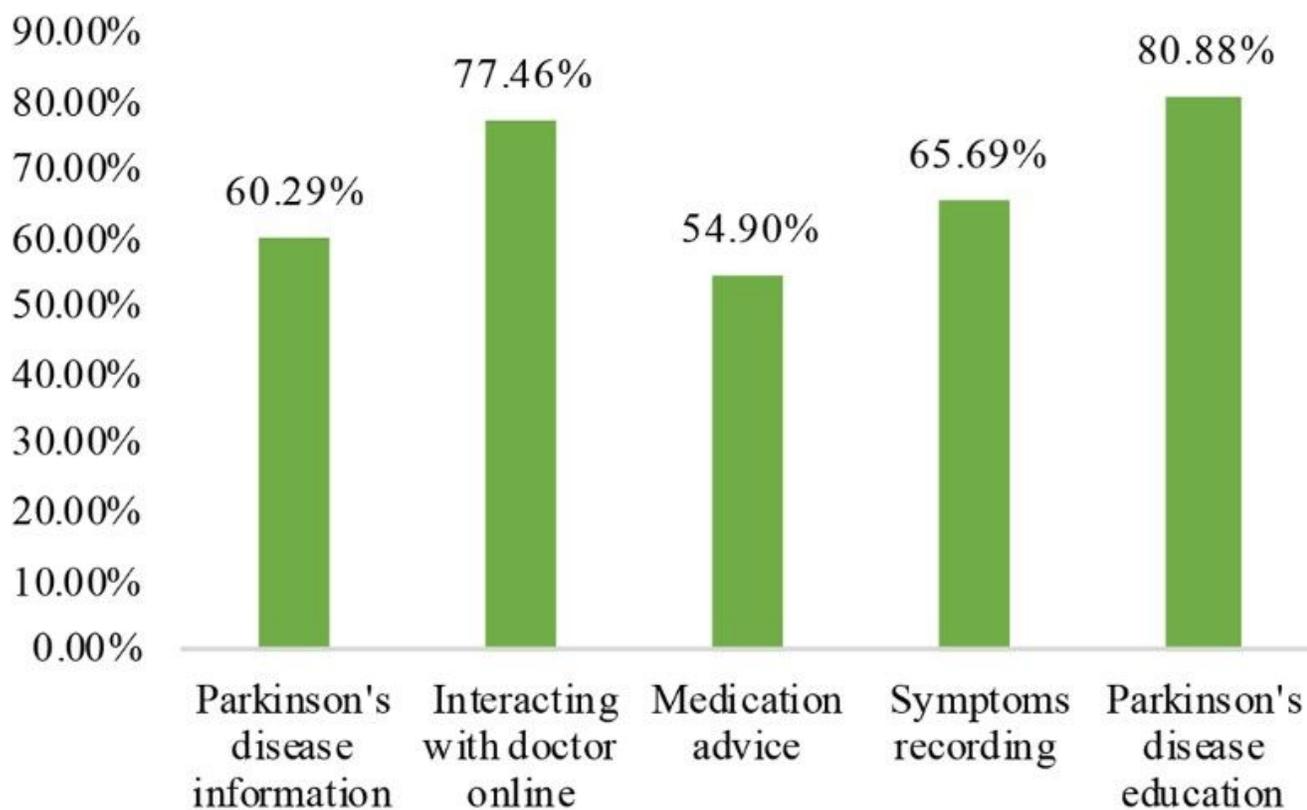
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## Figures



**Figure 1**

The methods of obtaining Parkinson's disease information



**Figure 2**

Participants' interests in contents of smartphone APPs for PD self-management