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An analysis of curative care expenditure for Parkinson's disease under different comorbidity conditions: an empirical study based on China

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Abstract

Background This study aims to evaluate the curative care expenditure (CCE) of Parkinson's disease (PD) under different comorbidity conditions to provide a reference basis for formulating health policies for PD.

Methods This study used a multi-stage stratified random sampling method to investigate 37,604 PD patients in 1,600 medical institutions in Sichuan, China, in 2019. Based on the System of Health Accounts 2011 (SHA2011), the scale of the CCE, financing schemes, institutional flows, and beneficiary groups of PD under different comorbidity conditions were calculated. Multiple linear regression model was used to analyze the factors influencing the hospitalization expenditure.

Results In 2019, the total CCE for PD in Sichuan was US$36.29 million, accounting for 0.11% of the province's total disease CCE and 0.005% of its gross domestic product (GDP) that year. Household out-of-pocket (OOP) payments (68.98% for outpatients and 42.26% for inpatients) and public financing schemes (30.69% for outpatients and 52.28% for inpatients) were the main sources of financing CCE. More than 80% of the CCE went to general hospitals, while less than 2% went to primary health-care institutions. As the comorbidity index increased, the CCE for PD exhibited an aging trend, with the low-, medium-, and high-comorbidity groups mainly concentrated in those in their fifties, those aged 60–79, and those over 80, respectively. The multiple linear regression analysis showed that the top three factors affecting hospitalization expenditure were the length of stay, surgery and institution level.

Conclusions The CCE for PD is high, and individuals and families are the main bearers of health expenditures. It is recommended to optimize medical insurance policies, increase outpatient insurance coverage, and gradually increase the level of insurance benefits. Furthermore, it is necessary to explore multi-party collaboration to establish a diversified and multi-level medical security system for PD.

Keywords Parkinson's disease, Curative care expenditure, SHA2011, Age-adjusted Charlson comorbidity index

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Background

Currently, Parkinson's disease (PD) is the second most common neurodegenerative disease, with Alzheimer's disease being the most common [1], and disability and death attributed to PD are increasing faster than those caused by any other neurological disease [2]. PD is mainly characterized by the following clinical manifestations: motor symptoms (tremor, myotonia, bradykinesia, and postural balance disorder) and non-motor symptoms (sleep disorders, olfactory disorders, autonomic nervous system dysfunction, and cognitive and mental disorders) [3]. Globally, the prevalence of PD in the entire population is only 0.3% [4]; however, its prevalence has doubled among older people, reaching 1–2% among people aged 65 and above and 3–5% for those over 85 years old [5]. In China, the prevalence rate of PD for people over 60 is 1.37% [6]. In 2019, there were approximately 2.84 million PD patients in China, accounting for 33.37% of PD patients worldwide [7]. As China's population ages, the number of PD patients will continue to increase at a significant rate. Some scholars have predicted that the number of PD patients in China will reach 4.94 million in 2030, accounting for 50% of the world's PD patients [8]; this will pose considerable challenges to China's medical and health system as well as its society.

PD has an insidious onset; it develops and worsens slowly, with a high disability rate. It not only severely affects the physical and mental health of patients and reduces their quality of life but also places a heavy economic burden on families, the medical system, and society, becoming a "black hole" that consumes national medical resources. In the United States, the annual curative expenditure for PD patients increased from US$14 billion in 2010 (US$22,129 per person) to US$25.4 billion (US$24,439 per person) in 2017 [9], and it is expected that, by 2037, the curative expenditure burden will be more than US$40.4 billion [10]. In Australia, the average annual curative expenditure for PD patients was 29,916 Australian dollars in 2012 [11]. In Sweden, the annual direct medical expenditure for each PD patient was SEK 43,114 in 2019 [12]. In Japan, the annual outpatient medical expenditure for PD patients totaled US$5,828.88 in 2008, with anti-PD drugs and other drugs accounting for 90.6% of the total outpatient medical expenditure [13]. It is evident that PD has caused a heavy economic burden in countries around the world. In China, the overall mean annual cost for PD was approximately US$925 in Shanghai in 2006, and these costs accounted for around half of the mean annual income [14]. In 2012, the direct medical expenditure for each PD patient in Guangzhou was US$2,299.40, with drugs accounting for the largest share (50.3%) [15]. A recent study showed that the average hospitalization expenditure for each PD patient in Hubei Province was US$1,759.9 [16]. However, most of the current studies have adopted a bottom-up accounting approach, which considers only the medical expenditure of the disease and not the overall consumption of social resources, and thus may underestimate the socio-economic losses caused by the disease. Thus, there is an urgent need to establish an expenditure accounting framework that can not only calculate the curative care expenditure (CCE) of PD accurately but also enhance the comparability of data between domestic and international levels.

PD patients have a long disease course, which may last for years or decades. Furthermore, older people, who have a high incidence of PD, are often not affected by only a single disease; rather, their diseases typically coexist with other common geriatric diseases. Numerous studies have shown that patients with PD often also suffer from multiple chronic diseases, such as diabetes, hypertension, coronary heart disease, stroke, osteoarthritis, and depression [15, 17–22]. The age-adjusted Charlson Comorbidity Index (ACCI) is a widely used comorbidity scoring system. It is based on the quantification of multiple comorbidities and takes into account the influence of the age factor [23], which more accurately reflects the burden of disease and the risk of death in elderly patients. Comorbidities not only aggravate the severity of the patient's original disease but also greatly increase the patient's medical burden. However, most current clinical research focuses on the relationship between PD and other comorbidities, and few scholars pay attention to the medical burden of PD under different comorbidity conditions.

To address the above research shortcomings, this study aims to adopt the System of Health Accounts 2011 (SHA2011) to more accurately and comprehensively calculate the CCE of PD under different comorbidity conditions in Sichuan Province, China. This can not only help us understand the scale of CCE for PD in Sichuan, but also reflect the distribution characteristics of the financing schemes, institutional flows, and beneficiary groups of CCE for PD based on different ACCIs. More importantly, this can provide a reference basis for meeting the multi-level and diversified PD health service needs of the population and aid in rationally allocating health resources and formulating healthcare policies.

Methods

Data source

This study is based on the secondary data analysis of data obtained from the 2019 Sichuan Province Statistical Yearbook [24], the 2019 Sichuan Province Health Financial Annual Report, and the 2019 Sichuan Province Health Statistics Yearbook [25]. The case data were obtained from 1,600 medical institutions in Sichuan

Province, China, which we collected during August-September 2020.

Data samples

This study adopted a multi-stage stratified random sampling method. In the first stage, regions that could represent different levels of economic development, population sizes, and geographic locations in Sichuan Province were included, while regions that were unwilling to cooperate and those with low levels of informatization were excluded. Ultimately, seven sample cities and prefectures were selected: Chengdu, Mianyang, Meishan, Guang'an, Zigong, Yibin, and Liangshan. At this stage, 35 municipal hospitals (including general hospitals, traditional Chinese medicine hospitals and specialized hospitals) and 7 municipal maternal and child health institutions were sampled. As Chengdu is the capital city of Sichuan, in addition to sampling municipal medical institutions, 17 provincial medical institutions were included, including the West China Hospital of Sichuan University, the Sichuan Provincial People's Hospital, and so on. In the second stage, four districts or counties in each city/prefecture were randomly selected as sample districts and counties. Subsequently, we sampled 113 district and county level hospitals and 28 district and county level maternal and child health institutions. In the third stage, four to ten streets, communities, or towns were selected as sample areas within the selected districts and counties. At this stage, 1,400 primary health-care institutions (including community health centres, township health centres, community health stations, and clinics) were selected. Finally, this study involved 1,600 sample medical institutions. Details are provided in Supplementary Table 1.

We obtained information about the patient's gender, age, length of stay, disease name, medical cost, and insurance from the information systems of the above institutions. And in 2020, we randomly selected 2–3 general hospitals/traditional Chinese medicine hospitals, 1 specialized hospital, and 1–2 primary health-care institutions in each city and prefecture to conduct on-site research and instruct relevant staff to extract the data on the first page of the case to ensure the completeness and accuracy of the data. Then, the collected sample data were classified and coded according to the International Classification of Diseases, 10th edition (ICD-10), and patients with ICD-10 codes G20-G21 were included in our study population [2, 10]. After excluding incomplete and incorrect information, we finally obtained a valid sample size of 37,604 cases (including 34,110 outpatient cases and 3,494 inpatient cases) to form the sample dataset for this study.

Statistical methods

The SHA2011 is a fully integrated health expenditure accounting system and has been widely adopted by the European Union, member states of the Economic Cooperation Organization and other countries [26]. The system accounts for health expenditure from three perspectives: financing, production and consumption of health care services [27]. Different from the previous bottom-up accounting method, SHA2011 adopts a top-down accounting method, which firstly obtains the total resources consumed by the society in the production of healthcare services at the macro level, and then apportions them according to a certain method to obtain the resources consumed by different types of diseases. The method not only provides a comprehensive response to the entire flow of health funds from collection, distribution and use by beneficiaries, but also improves the comparability of health expenditure data internationally and better meets the needs of health system analysts and policymakers.

Based on the SHA2011 theoretical framework and using top-down accounting principles, the CCE for PD was calculated. In this study, curative income, government basic expenditure subsidies, and project subsidies were considered in the calculation scope, while capital construction costs, equipment, depreciation, and other expenses that do not directly consume human health service resources were not included. Notably, this study has only focused on treatment services, and the preventive expenses of medical institutions have been excluded.

The calculation approach for outpatients and inpatients was the same. Below, outpatient services are used as an example to introduce the calculation method:

$$S_{CCE} = S_{CI} + S_{BS} + S_{PS} \tag{1}$$

S_{CCE} in formula (1) represents the total CCE of the medical institutions in Sichuan. S_{CI} refers to the curative income of the province, excluding preventive services; S_{BS} refers to the basic curative expenditure subsidies given by the government to medical institutions throughout the province, which mainly includes funds for personnel and other public purposes; and S_{PS} represents project subsidies for the entire province, such as basic drug subsidies, maternity and childbirth subsidies, and medical reform subsidies. This information is provided by government health investment monitoring data.

Among these, S_{CI} and S_{BS} are calculated using the following formula:

$$S_{CI} = S_{TOI} \times \left(1 - \frac{\alpha_p}{\alpha}\right) \tag{2}$$

In formula (2), S_{TOI} refers to the total outpatient income of Sichuan in 2019; α_p refers to the preventive outpatient income of the sample institutions; α represents the total outpatient income of the sample institutions; and $1-\frac{\alpha_p}{\alpha}$ refers to the proportion of the curative income of the sample institutions after deducting prevention revenue.

$$S_{BS} = S_{BCS} \times \left(1 - \frac{N_{IBD}}{N_{IBD} + N_{COV} \times K}\right) \quad (3)$$

$$N_{COV} = N_{TOV} \times \left(1 - \frac{N_{POV}}{N_{OV}}\right) \quad (4)$$

In formula (3), S_{BCS} is the subsidy for the total basic curative expenditure in Sichuan in 2019. N_{IBD} represents the number of inpatient bed days in the sample medical institutions; N_{COV} is the number of curative outpatient visits in the sample medical institutions; and the coefficient K is a constant 0.1, meaning that ten outpatient clinics are equivalent to one inpatient bed day. Among them, N_{COV} is calculated by formula (4); N_{TOV} represents the total number of outpatient visits in Sichuan in 2019; N_{POV} refers to the number of preventive service outpatient visits in the sample medical institutions; and N_{OV} refers to the total number of outpatient visits in the sample medical institutions.

Next, the top-down accounting principle was used to allocate the CCE of the medical institutions in the province to each patient in the sample medical institutions. The formulas are as follows:

$$E_{CI} = S_{CI} \times \frac{\delta}{\sum_{i=1}^{n} \delta_i} (i = 1, 2, 3 \ldots\ldots n) \quad (5)$$

$$E_{BS} = S_{BS} \times \frac{\phi}{\sum_{m=1}^{n} \phi_m} (m = 1, 2, 3 \ldots\ldots n) \quad (6)$$

$$E_{PS} = S_{PS} \times \frac{\beta}{\sum_{w=1}^{n} \beta_w} (w = 1, 2, 3 \ldots\ldots n) \quad (7)$$

In formulas (5), (6), and (7), E_{CI}, E_{BS}, and E_{PS} represent the treatment income, basic expenditure subsidy, and project subsidy allocated to each patient, respectively. δ represents the outpatient expenditure of each patient in the different types of sample medical institutions; ϕ represents the number of visits of each patient in the different types of sample medical institutions; and β represents the project subsidy for each patient in the different types of sample medical institutions.

Formula (8) represents the summary of CCE for patients with the same characteristics, such as gender, age, and disease in the region.

$$\sum_{i=1}^{n} E_{CCE} = \sum_{i=1}^{n} E_{CI} + \sum_{i=1}^{n} E_{BS} + \sum_{i=1}^{n} E_{PS} (i = 1, 2, 3 \ldots .n) \quad (8)$$

Finally, the CCE of different dimensions for PD patients in Sichuan in 2019 were calculated using the above formula.

Measurement of comorbidity profile

This study used the ACCI defined by Charlson et al. [28] to express the comorbidity status of patients. The ACCI is a combination of Charlson Comorbidity Index (CCI) and age-adjusted index [29, 30]. The CCI was calculated by summing the corresponding weight indices for the 17 clearly defined diseases (Supplementary Table 2). In addition, we adjusted for age as an additional factor, by adding 1 point for every 10 years of life after the age 40 (e.g., one point for 50–59 years, two points for 60–69 years, three points for 70–79 years, and so on). Finally, we summed the CCI score and the age-adjusted score to obtain the ACCI (range 0–36), with a further grouping into low comorbidity group (ACCI = 0–1), medium comorbidity group (ACCI = 2–5), and high comorbidity group (ACCI ≥ 6).

Analysis of influencing factors of hospitalization expenditure for PD

The hospitalization expenditure was not normally distributed, but turned normally distributed after a logarithmic transition. Thereby, the hospitalization expenditure was logarithmically transformed as the dependent variable, and a multiple linear regression model was performed to analyze the influencing factors of patients with PD. The independent variables were gender, ACCI, surgery, length of stay, medical insurance, institution level, institution category, economic region. Because the ACCI already included age, age was not included in the regression model separately. Data were analyzed using SPSS 25.0 software, and a Pvalue < 0.05 was considered to be statistically significant.

Results

General characteristics of PD patients

This study investigated a total of 37,604 PD patients in Sichuan in 2019, including 34,110 outpatients and 3,494 inpatients. In terms of age distribution, the average age of the PD patients was 66.43 years old, with the youngest being 5 years old and the oldest being 101 years old. In terms of gender distribution, there were slightly more male patients (18,858,50.15%) than female ones (18,746,49.85%). The other general characteristics are shown in Table 1.

Table 1 The general characteristics of PD patients in Sichuan, China in 2019 (n,%)

Variables	Total patients	Service function	
		Outpatients	Inpatients
Age(Mean ± SD)	66.43 ± 12.58	66.00 ± 12.70	70.62 ± 10.42
Gender			
Male	18,858(50.15)	16,997(49.83)	1861(53.26)
Female	18,746(49.85)	17,113(50.17)	1633(46.74)
ACCI			
0–1	8388(22.31)	7999(23.45)	389(11.13)
2–5	29,028(77.19)	25,985(76.18)	3043(87.09)
≥6	188(0.50)	126(0.37)	62(1.77)
Medical insurance			
No	21,470(57.09)	21,043(61.69)	427(12.22)
Yes	16,134(42.91)	13,067(38.31)	3067(87.78)
Length of stay(Mean ± SD)	-	-	13.59 ± 14.91
Institution level			
Provincial institution	19,529(51.93)	18,444(54.07)	1085(31.05)
Municipal institution	12,227(32.52)	10,580(31.02)	1647(47.14)
District/county institution	5848(15.55)	5086(14.91)	762(21.81)
Institution category			
General hospital	28,103(74.73)	25,551(74.91)	2552(73.04)
Traditional Chinese medical hospital	7145(19.00)	6637(19.46)	508(14.54)
Specialized hospital	1769(4.70)	1370(4.02)	399(11.42)
Other institution	587(1.56)	552(1.62)	35(1.00)
Economic region			
High-economic region	19,613(52.16)	18,129(53.15)	1484(42.47)
Medium-economic region	17,100(45.47)	15,175(44.49)	1925(55.09)
Low-economic region	891(2.37)	806(2.36)	85(2.43)

Table 2 CCE of different service functions for PD patients in Sichuan, China in 2019

ACCI	Outpatient		Inpatient	
	CCE $Million	Average expenditure per visit ($)	CCE $Million	Average expenditure per visit ($)
0–1	3.51	438.89	2.18	5602.23
2–5	12.71	489.23	17.41	5721.45
≥6	0.08	661.12	0.39	6307.93
total	16.31	478.06	19.98	5718.58

General situation of CCE for PD

In 2019, the total CCE for PD in Sichuan was US$36.29 million, accounting for 0.11% of the province's total disease CCE and 0.005% of its GDP that year. The outpatient CCE was US$16.31 million (44.94%), with an average per-visit expenditure of US$478.06. The inpatient CCE was US$19.98 million (55.06%), with an average per-visit expenditure of US$5,718.58. As the ACCI increased, both the average outpatient per-visit expenditure and the average inpatient expenditure showed an upward trend (Table 2).

Health financing schemes of CCE for PD

Upon analyzing the financing schemes of CCE for PD, it was found that more than 50% of the CCE came from household out-of-pocket (OOP) payments, followed by social health insurance (34.82%). Of the outpatient CCE, OOP payments accounted for 68.98%, followed by social health insurance (25.62%). Compared with outpatient services, inpatient schemes of financing were more diverse, with social health insurance accounting for 42.33%, followed by OOP payments (42.26%), government financing schemes (9.95%), and voluntary financing schemes (5.46%) (Table 3).

Upon analyzing the financing schemes for different comorbidity groups, it was found that OOP payments were the main financing schemes for both outpatients and inpatients. Among outpatient services, the proportions of OOP payments in the low-, medium-, and high-comorbidity groups were 65.33%, 69.92%, and 79.36%, respectively, and the proportions of social health insurance were 29.85%, 24.51%, and 16.70%, respectively. Compared to outpatient services, the proportion of OOP payments for hospitalization was significantly lower. The proportions of OOP payments for low-, medium-, and high-comorbidity groups were 36.91%, 42.86%, and 45.59%, respectively, while the proportions of social health insurance were 33.02%, 43.43%, and 45.39%,

Table 3 Distribution of financing schemes for CCE of different service functions for PD patients in Sichuan, China in 2019

	Outpatient		Inpatient		Total	
	$ Million	Proportion (%)	$ Million	Proportion (%)	$ Million	Proportion (%)
Public financing scheme	5.00	30.69	10.45	52.28	15.45	42.58
Government financing scheme	0.83	5.07	1.99	9.95	2.82	7.76
Social health insurance	4.18	25.62	8.46	42.33	12.64	34.82
Voluntary financing scheme	0.05	0.33	1.09	5.46	1.14	3.15
Commercial health insurance	0.00	0.00	0.96	4.81	0.96	2.65
Non - profit organization financing scheme	0.00	0.00	0.04	0.22	0.04	0.12
Enterprise financing scheme	0.05	0.33	0.08	0.42	0.14	0.38
Household out-of-pocket payment	11.25	68.98	8.44	42.26	19.69	54.27

Table 4 Distribution of financing schemes for CCE of different comorbidity groups for PD patients in Sichuan, China, in 2019

	ACCI = 0–1		ACCI = 2–5		ACCI ≥ 6	
	$ Million	Proportion (%)	$ Million	Proportion (%)	$ Million	Proportion (%)
Outpatient						
Public financing scheme	1.19	33.85	3.80	29.88	0.02	20.64
Government financing scheme	0.14	4.00	0.68	5.37	0.003	3.94
Social health insurance	1.05	29.85	3.12	24.51	0.01	16.70
Voluntary financing scheme	0.03	0.82	0.03	0.20	0.00	0.00
Commercial health insurance	0.00	0.00	0.00	0.00	0.00	0.00
Non - profit organization financing scheme	0.00	0.00	0.00	0.00	0.00	0.00
Enterprise financing scheme	0.03	0.82	0.03	0.20	0.00	0.00
Household out-of-pocket payment	2.29	65.33	8.89	69.92	0.07	79.36
Inpatient						
Public financing scheme	1.03	47.41	9.20	52.86	0.21	53.90
Government financing scheme	0.31	14.39	1.64	9.43	0.03	8.50
Social health insurance	0.72	33.02	7.56	43.43	0.18	45.39
Voluntary financing scheme	0.34	15.69	0.75	4.28	0.002	0.61
Commercial health insurance	0.31	14.27	0.65	3.73	0.001	0.30
Non - profit organization financing scheme	0.00	0.16	0.04	0.23	0.001	0.28
Enterprise financing scheme	0.03	1.26	0.06	0.33	0.0001	0.03
Household out-of-pocket payment	0.80	36.91	7.46	42.86	0.18	45.49

respectively; furthermore, voluntary financing schemes accounted for 15.69%, 4.28%, and 0.61%, respectively (Table 4).

Allocation of CCE in different medical institutions for PD

The institutional flows of outpatient and inpatient CCE for PD were largely the same, with general hospitals being the main sources. Among outpatient services, the CCE going to general hospitals totaled US$14.72 million (90.28%), while those going to traditional Chinese medical hospitals and primary health-care institutions were US$1.12 million (6.86%) and US$0.22 million (1.37%), respectively. Among inpatient services, the CCE going to general hospitals were as high as US$15.59 million (78.02%), whereas the CCE going to specialized hospitals and traditional Chinese medical hospitals were US$2.44 million (12.21%) and US$1.78 million (8.92%), respectively; the CCE going to primary health-care institutions were the lowest at only US$0.16 million (0.82%).

As the comorbidity index increased, the proportion of outpatient CCE going to general hospitals also gradually increased, reaching 96.42% in the high-comorbidity group. In contrast, as the comorbidity index increased, the proportion of inpatient CCE going to general hospitals gradually decreased, with the proportion in the high-comorbidity group dropping to 58.16%, and the proportion of inpatient CCE going to specialized hospitals increased, from 2.58% in the low-comorbidity group to 36.87% in the high-comorbidity group (Fig. 1).

The beneficiary group of CCE for PD

Overall, the CCE for men were higher than those for women for both outpatient and inpatient services. Outpatient CCE for men totaled US$8.36 million (51.26%), while those for women totaled US$7.95 million (48.74%); inpatient CCE for men totaled US$10.97 million (54.91%), while those for women totaled US$9.01 million (45.09%). For outpatient services, the CCE were mainly concentrated in the over-60 age group. For men, expenditure peaked in the 70～age group at US$2.85 million, representing 34.15% of their total CCE. For women, expenditure peaked in the 60～age group at US$2.75 million,

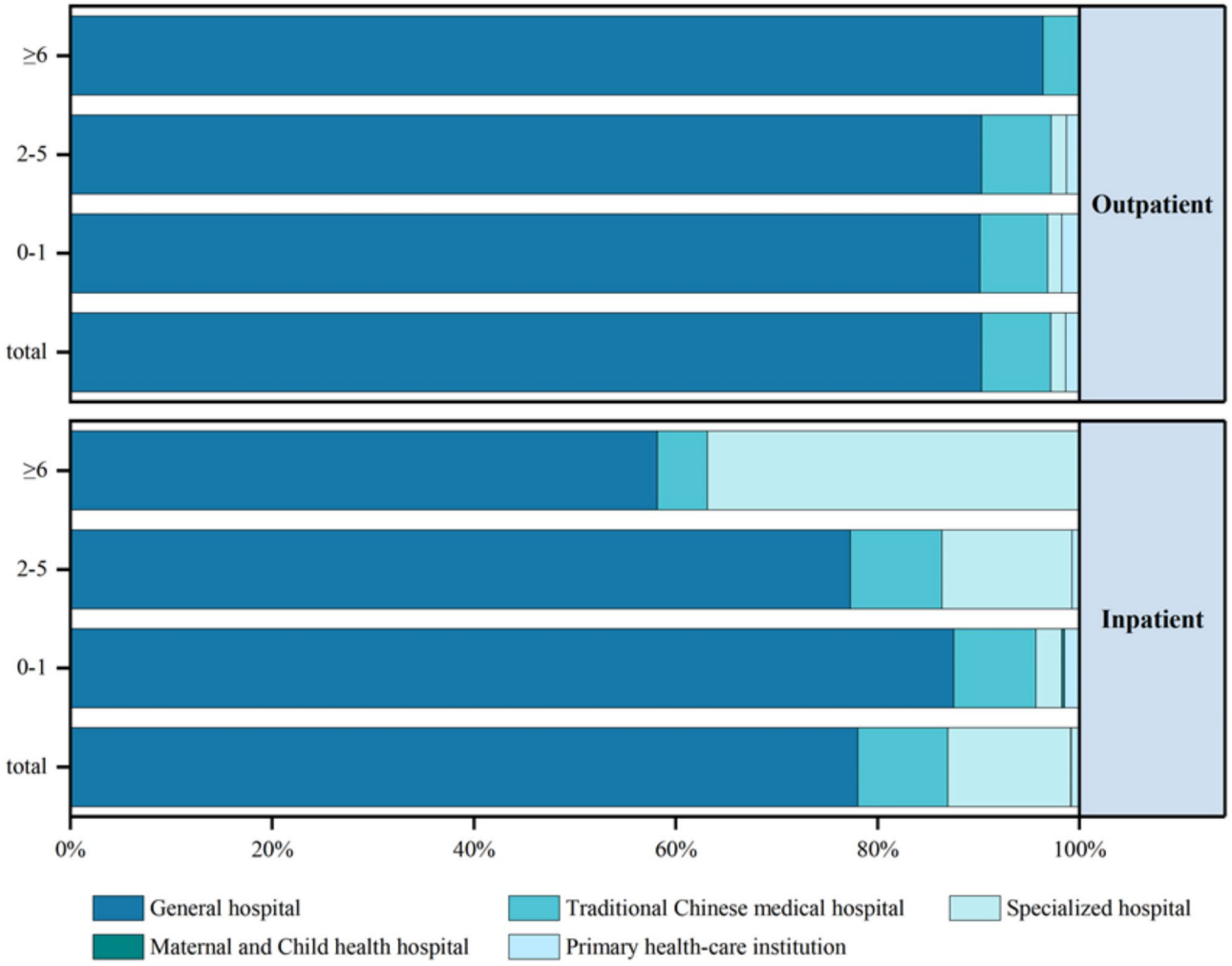

Fig. 1 Allocation of CCE in different medical institutions for PD in Sichuan, China in 2019

representing 34.63% of their total CCE. The CCE for inpatient services were also mainly concentrated in the over-60 age group. For both men and women, the highest expenditures were concentrated in the 60～age group; these amounted to $4.30 million and $3.16 million, respectively, representing 39.20% of the CCE for men and 35.04% of the CCE for women.

As the comorbidity index increased, PD CCE across genders showed a trend of aging. For outpatient services, the peak expenditures for men in the low-, medium-, and high-comorbidity groups were distributed across ages 50~, 70~, and 70~, respectively, and amounted to US$1.07 million, US$2.83 million, and US$0.03 million, respectively. The peak expenditures for women in the low-, medium-, and high-comorbidity groups were distributed across ages 50~, 60~, and 80~, respectively, and amounted to US$1.16 million, US$2.75 million, and US$0.02 million, respectively.

In the inpatient sector, the distribution of peak expenditure for men and women in the low-comorbidity group was consistent and concentrated in the 50～age group, namely US$0.89 million and US$0.96 million, respectively; the peak expenditure distribution for men and women in the medium-comorbidity group was concentrated in the 60～age group, namely US$4.29 million and US$3.15 million, respectively; and the peak expenditure distribution for men and women in the high-comorbidity group was concentrated in the 90～age group, namely US$0.08 million and US$0.15 million, respectively (Fig. 2).

Influencing factors of hospitalization expenditure

The results of multiple linear regression analysis showed that F = 233.47, P<0.001, thereby establishing the regression equation. From the perspective of the standardized regression coefficient, the first three factors affecting hospitalization expenditure were the length of stay, surgery and institution level (P<0.001). The linear regression model can explain the 46.4% change in total hospitalization expenditure (Table 5).

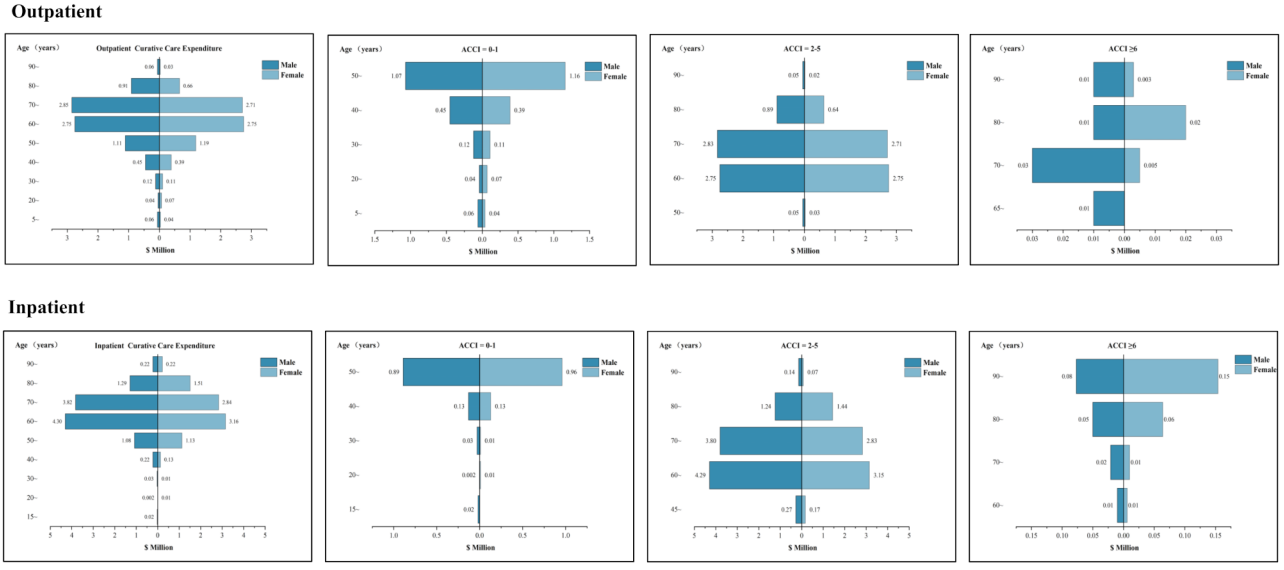

Fig. 2 Characteristics of beneficiary groups with CCE for PD under different comorbidity conditions in Sichuan, China, 2019

Table 5 Multiple linear regression analysis of inpatient expenditure for PD

	Non-standardized coeffcients		Standardized regression coeffcient(β)	t	*P*
	B	SE			
Constant	8.94	0.05		183.87	< 0.001
Length of stay	0.02	0.00	0.36	26.43	< 0.001
Surgery					
No					
Yes	0.85	0.04	0.31	23.96	< 0.001
Institution level					
Provincial institution					
Municipal institution	-0.49	0.03	-0.26	-15.02	< 0.001
District/county institution	-0.80	0.04	-0.35	-20.59	< 0.001
ACCI					
0–1					
2–5	0.12	0.04	0.04	3.10	0.002
≥6	0.36	0.10	0.05	3.78	< 0.001
Medical insurance					
No					
Yes	0.20	0.04	0.07	5.16	< 0.001
Institution category					
General hospital					
Traditional Chinese medical hospital	-0.09	0.03	-0.03	-2.62	0.009
Specialized hospital	-0.20	0.04	-0.07	-4.53	< 0.001
Other institution	-0.87	0.12	-0.09	-7.22	< 0.001
Economic region					
High-economic region					
Medium-economic region	-0.38	0.03	-0.20	-13.60	< 0.001
Low-economic region	-0.07	0.08	-0.01	-0.85	0.397
Gender					
Male					
Female	-0.04	0.02	-0.02	-1.71	0.088

Discussion

Based on the SHA 2011, this study analyzed the CCE of PD under different comorbidity conditions in Sichuan, China, in 2019. The results show that the total CCE for PD in Sichuan in 2019 amounted to US$36.29 million, accounting for 0.11% of the province's total CCE. The average expenditure per outpatient visit was US$478.06, accounting for 13.35% of the disposable income per capita and 5.91% of the GDP per capita. The average expenditure per hospital stay was US$5,718.58, which was 159.73% of the disposable income per capita and 70.75% of the GDP per capita. The average expenditure of PD in Sichuan was significantly higher than that in Guangzhou [15], China, in 2012. The significant differences between the results of this study and those of Guangzhou may be attributed to the variations in accounting methods, economic development and healthcare resource allocation among different regions. Nevertheless, this study provides a novel idea for calculating CCE for PD and can be used for formulating policy measures.

The study found that the financing schemes for PD CCE in Sichuan are not adequate. Household spending on healthcare is too high, which can easily lead to poverty or a return to poverty due to illness. When analyzing the different service functions, it was found that the proportion of OOP payments for outpatient services (68.98%) was significantly higher than that for inpatient services (42.26%); this is consistent with the research results from the city of Guangzhou [15]. Currently, PD Patients can claim reimbursement from health insurance reimbursement services for outpatient treatment. Nevertheless, the establishment of the minimum payment standards, the annual maximum payment limit, and the different reimbursement rates of various levels of medical institutions have resulted in an unfavorable reimbursement rate for outpatients with PD [31]. In China, the current health insurance system is mainly designed to contribute to the medical expenditure of hospitalized patients, which is an important reason for the low OOP payment rate for hospitalization. However, due to insufficient outpatient compensation, medical institutions have performed certain low-standard admissions and unnecessary hospitalizations, which has led to a sustained increase in the overall hospitalization rate in China. This phenomenon not only increases patients' medical expenditure but also wastes national medical and health resources. It is recommended that the medical insurance department pay attention to the discrepancy between reimbursement rates for outpatient and inpatient services, expand the coverage of basic medical insurance for outpatient services, and improve the level of insurance reimbursement for outpatient services.

This study also found that the proportion of voluntary financing schemes is low, especially for outpatient services, and that commercial health insurance is nearly non-existent. It is recommended that government departments strengthen the framework of the triple security system (consisting of basic health insurance, critical illness insurance, and medical aid), actively promote the development of commercial health insurance, explore the establishment of a diversified and multi-tiered PD medical security system, and facilitate more urgent outpatient compensation.

According to the analysis of different comorbidity states, the higher the comorbidity index, the greater the economic burden on individuals. Previous studies have shown that the number of chronic diseases and comorbidity rates increase with age [32], with comorbidity rates as high as 65.6% in the over-65 age group in China [33]. With increasing age, comorbidities gradually increase and patients' conditions slowly deteriorate [34], and they typically require more drug treatments, medical services, and formal care, which greatly increases the medical burden on patients [35, 36]. This further highlights the importance of chronic disease prevention and multi-disease management among older people.

Furthermore, the results of this study show that, for both outpatient and inpatient services, general hospitals account for most of the CCE, while primary care facilities account for the least. This could be due to residents' preferences regarding medical treatment. Elderly patients prefer to go to higher-level hospitals for better medical care than primary healthcare facilities [37], leading to China's current medical treatment pattern: Grade A tertiary hospitals are "crowded", while primary healthcare facilities are "empty". In 2020, the Chinese Medical Association published the "Guideline for primary care of Parkinson's Disease (2019)". These guidelines describe the early detection, diagnosis, treatment, referral, and disease management of PD from the perspective of primary healthcare and suggest that primary healthcare facilities can also undertake the diagnosis and treatment of PD and play the role in safeguarding people's health. Therefore, it is recommended to increase government investment in primary healthcare institutions, improve service capacity and diagnosis/treatment standard at the primary level, and promote the inflow of patients to primary healthcare institutions.

As the comorbidity index increases, the proportion of inpatient CCE for PD in general hospitals gradually decreases, while the proportion in specialized hospitals increases significantly. On the one hand, this could be because general hospitals limit the length of stay. The average expenditure per visit and the average length of hospital stay are important measures in the evaluation of medical quality by health authorities. Hospitals need to expedite bed turnover to improve operational efficiency, and the performance evaluation by relevant authorities

has undoubtedly increased hospitals' focus on the length of stay; this has led to illegal actions by hospitals, such as splitting hospital stays or forcibly transferring patients to other hospitals. On the other hand, with an aging population and an increasing number of people with chronic diseases, China is vigorously exploring a model that combines medical care and elderly care. Some specialized hospitals have addressed the needs of older people for health and elderly care services and introduced a new medical service model that integrates medical and elderly care to attract more older people.

In general, CCE is higher for men than for women, mainly due to epidemic characteristics: The incidence rate in men is higher than that in women [38–40]. This may be related to the fact that men are more likely to experience higher occupational exposure factors and poor lifestyle habits [41], while estrogen may have a potential neuroprotective effect in women [42]. In addition, this study also found an aging trend in CCE as the comorbidity index increased.

More importantly, PD does not affect only older people. In recent years, studies have found that PD is gradually affecting younger people as well [43]. Nearly 25% of PD patients have an onset age of less than 65 years, and 5–10% have an onset age of less than 50 years [3]. In this study, the youngest PD patient in the outpatient category was 5 years old, and the youngest PD patient in the inpatient category was 15 years old, which is consistent with previous studies [44, 45]. For patients with early-onset PD whose onset age is less than 50 years, genetic factors are an important cause of the disease [46, 47]. Therefore, it is recommended that people with a family history of PD undergo early screening, such as genetic counseling and genetic testing [48], to ensure an early diagnosis and carry out clinical intervention in advance to delay the progression of the disease and thereby improve the patient's quality of life.

The results of multiple linear regression analysis showed that the top three factors influencing hospitalization expenditure were the length of stay, surgery and institution level. The longer hospital stays in PD patients are associated with higher CCE, which is consistent with other studies [15]. The surgery is another key factor influencing hospitalization expenditure. If the patient requires deep brain stimulation (DBS) surgery, the costs of batteries, wires, electrodes, and other related equipment are expensive and are not covered by medical insurance [16]. Surgery not only directly increases hospitalization expenses but also incurs high medical expenditure by prolonging the length of stay. Generally speaking, the level of a medical institution is closely related to its level of treatment, size, accessibility of technology and other factors [49]. Provincial institutions have the technology and quality of service to better meet the needs of patients, and accordingly, their expenses may be higher.

Overall, the findings of this study not only support the concept of healthy ageing [50], but also provide empirical support for the United Nations Decade of Healthy Ageing, which is being actively promoted by WHO, and can help to promote the formulation and implementation of relevant policies to jointly promote the health and well-being of the elderly population.

Limitations

This study has certain limitations, as it may have underestimated the actual CCE of PD. First, the diagnosis cycle of PD is long, with the disease often taking more than a year to be officially diagnosed. PD patients who have not yet been clearly diagnosed may be missed. Second, this study only measured the CCE for PD patients in 2019 and was unable to dynamically observe the changing trend of CCE. Finally, our findings may not be generalizable to other populations, as this study was only conducted in Sichuan Province, China. Despite these limitations, this study systematically answers core questions, such as how much treating PD costs, where these costs come from, where these costs go, and which groups these costs are used for.

Conclusions

As the Chinese population continues to age, China's PD patients will account for more than half of the world's PD patients in the future, which will impose a heavy economic burden on China's medical system and society. Based on the SHA2011, this study measured core issues, such as the expenditure scale, financing schemes, institutional flows, and beneficiary groups of PD. The results show that the total CCE for PD in Sichuan in 2019 was US$36.29 million. The average expenditure is high, and individuals are still the main bearers of health expenditures. CCE mainly goes to general hospitals, with primary healthcare institutions accounting for a small proportion. It is noteworthy that specialized hospitals play an important role in inpatient treatment services for PD. As the comorbidity index increases, CCE for both men and women show an aging trend. It is recommended to optimize medical insurance policies, improve the extent of outpatient insurance benefits, strengthen the primary medical service systems and improve primary-level PD diagnosis and treatment capabilities. Furthermore, effective early screening of PD is of great significance in the prevention and treatment of PD.

Abbreviations

ACCI	Age-adjusted Charlson Comorbidity Indexes
CCE	Curative care expenditure
GDP	Gross domestic product
OOP	Household out-of-pocket

PD Parkinson's disease
SHA2011 The System of Health Accounts 2011

Supplementary Information

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Supplementary Material 1

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Author contributions
YLZ: Analyzed the data, Drafted the manuscript, Writing-review and editing. YRL, JL, QYW: Conceptualization, Supervision. LMF, XLZ: Visualization. LY: Methodology. All authors read and approved the final manuscript.

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

Declarations

Ethics approval and consent to participate
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Hospital of Chengdu University of Traditional Chinese Medicine (approval no. 2020KL-001). Informed consent was obtained from all individual participants included in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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