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Cost burden and temporal trends of herpes zoster in China: Evidence from Beijing's health records

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ABSTRACT

Objective: Herpes zoster poses a significant health threat to the aging population in China. This study aimed to analyze the cost burden and temporal trends of herpes zoster in China.
Methods: This study encompassed herpes zoster outpatients from 15 hospitals between 2016 and 2023 and herpes zoster inpatients from 175 hospitals between 2013 and 2023. We used descriptive analysis and log-linear model to investigate herpes zoster related cost burden and their temporal trends during the selected period.
Results: Over the past eight years, outpatient visits increased by about 23.8 % across the selected hospitals, while inpatient discharges increased by approximately 124.8 %. About 23.6 % of the outpatient cases were under 45 years of age. The cost per outpatient visit fluctuated at approximately 57 USD, while the cost per hospitalization increased by over 20 %, reaching around 1931 USD in 2023. Older patients and those with post-herpetic neuralgia experienced higher herpes zoster related healthcare costs and utilization.
Conclusions: Our findings suggest that although the average cost per visit or discharge changed little in China, the growing demand for herpes zoster healthcare highlights the necessity of more preventive efforts to reduce the burden on both individuals and the healthcare system.

1. Introduction

Herpes zoster is a disease resulting from reactivation of latent varicella–zoster virus, often characterized by a painful vesicular dermatomal rash(Thomas and Hall, 2004; Cohen, 2013; John and Canaday, 2017). Postherpetic neuralgia (PHN), the most common complication of herpes zoster, manifests as persistent pain extending well beyond cutaneous healing(Gnann and Whitley, 2002; Le and Rothberg, 2019). The risk of developing PHN among those with herpes zoster varies from 10 % to 50 % depending on age and the diagnostic criteria(Cohen, 2013). The likelihood of both developing herpes zoster and PHN escalates with age, especially among individuals over 50 years. The lifetime risk of herpes zoster reaches 50 % by the age of 85, and the incidence of PHN is around 50 % among herpes zoster patients aged over 85 years(John and Canaday, 2017). For numerous countries grappling with the aging demographic, such as China, age-related diseases like herpes zoster pose an increasingly significant threat to the attainment of universal health coverage and warrant greater research focus.

Evidence regarding the incidence, prevalence, and cost burden of herpes zoster, as we know, predominantly originates from developed countries(Gater et al., 2015; van Oorschot et al., 2021; Yin et al., 2021; San Martin et al., 2023). A UK study indicated an overall annual incidence of 5.23 cases per 1000 person-years, with costs amounting to approximately £103 per herpes zoster case and £397 per PHN episode (Gauthier et al., 2009). German research reported an annual incidence of 5.79 cases per 1000 individuals, incurring expenses of €376 per herpes zoster case and an additional €1645 per PHN case(Ultsch et al., 2013). Canadian data revealed an incidence rate of 5.7 cases per 1000 person-years, with costs averaging $79 per herpes zoster episode and $14,258 per hospitalization(Friesen et al., 2017). A study from South Korea documented an annual herpes zoster clinical visit and hospitalization rate of 12.54 and 0.32 cases per 1000 population, along with an estimated direct cost for herpes zoster of approximately $123.75 million yearly, inclusive of 617,781 outpatients and 15,837 inpatients.(Choi

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et al., 2010).

Studies on the incidence of herpes zoster and its associated costs in China are limited, despite the significant escalating burden of age-related disease(Yin et al., 2021; Sun et al., 2021). A systematic literature review revealed only three English studies reported herpes zoster incidences in mainland China from 2000 to 2019, with the incidence rates ranging from 1.9 to 5.8 cases per 1000 person-years. Additionally, only two English studies reported the cost burden of herpes zoster in mainland China(Yin et al., 2021). Among these, one study compared the costs of five different therapies, costs ranging from 222 to 372 RMB (32 to 53 USD), while only one study reported mean costs of 4502 RMB (643 USD) per herpes zoster related hospitalization and 544 RMB (78 USD) per outpatient visit(Li et al., 2012, 2016; Yin et al., 2021). Moreover, a recent study utilizing an administrative database from Yinzhou district in China reported that the mean inpatient and outpatient costs for patients with new-onset herpes zoster were approximately 8117 RMB (1160 USD) and 560 RMB (80 USD) per visit or discharge, respectively (Sun et al., 2021).

The health burden associated with herpes zoster, besides the painful rash and mental stress, also includes a financial load that warrants greater attention. Although there are several district or community level studies offering valuable insights into the cost burden of herpes zoster in China, a temporal analysis of cost burden trends is lacking, limiting the ability to more accurately predict herpes zoster burden in the future(Li et al., 2016; Yin et al., 2021; Sun et al., 2021). In addition, given that many patients tend to use healthcare in the city hospitals instead of the local hospitals, herpes zoster related cost burdens based on the analysis of a larger data consisting both district and city hospitals is also necessary,

The objective of this study was to fill the gap regarding herpes zoster related cost burden in China. Using municipal-level data encompassing over 480,000 herpes zoster visits and over 27,000 herpes zoster hospitalizations, this study analyzed the costs for both outpatient and inpatient services for herpes zoster only patients and those with PHN, as well as trend of their cost burden over time. We believe our study would make contributions to better understanding the cost burden of herpes zoster, thereby offering valuable insights for more effective policy design aimed at financing age-related diseases in the context of an era of rapid aging.

2. Methods

2.1. Data source

This study obtained data from the Beijing Hospital Electronic Record Database, an administrative database characterized by rigorous quality checks and mandatory reporting requirements during data collection. Considering the availability of outpatient and inpatient data, we finally selected 15 hospitals for outpatient service analysis and 175 hospitals for inpatient service analysis, covering over 18 % of outpatient visits and over 85 % of inpatient discharges in Beijing. The database was meticulously audited when collected and has been utilized in some previous studies(Niu et al., 2020; Chu et al., 2021; Zhao et al., 2023). We believe that our data are among the most representative currently available for analysis. For outpatient data, 15 hospitals included all hospitals currently available for analysis in the database with high quality data during 2016 to 2023. All of their herpes zoster related outpatient records were included. The share of outpatient visits in the selected 15 hospitals remained relatively stable, and their cost per visit was close to the average level across all hospitals in Beijing (see Table A.1 in the supplemental file). Regarding hospitalization data, it encompassed all hospitals in principle, with the exception of military hospitals.

To evaluate cost burden of herpes zoster and their temporal trends, we included outpatients or inpatients with a primary diagnosis of either herpes zoster (ICD-10 code: B02) or PHN (ICD-10 code: G53.0) in aforementioned database. Table A.2 in supplemental file shows that patients with herpes zoster as the primary diagnosis accounted for approximately 34.0 % of herpes zoster related outpatient visits and 27.3 % of inpatient discharges. Table A.3 in supplemental file shows that for individuals incurring PHN, only 18.9 % of outpatients and 1.9 % of inpatients used herpes zoster related care before they were diagnosed with post-herpetic neuralgia in the year. After excluding records with incorrect demographic and cost information, the selected data comprised 482,933 visits across 15 hospitals from 2016 to 2023 and 27,956 discharges across 175 hospitals from 2013 to 2023.

All data have been anonymized and the analysis process is under full supervision by Beijing Municipal Health Big Data and Policy Research Center, ensuring no risk of personal information leakage. No further ethical approval for this type of study is required by Beijing Municipal Health Big Data and Policy Research Center.

2.2. Measurements

Cost burden of herpes zoster was assessed by the cost per outpatient visit and cost per inpatient discharge. Cost per visit or discharge encompass all direct healthcare expenses incurred during a single outpatient visit or hospital stay, including all treatment and medication expenses paid by out-of-pocket, insurance or other ways. In addition, we also analyzed the length of stay (LOS) per hospitalization. Considering those with multiple outpatient visits or hospital discharges, we further calculated the healthcare utilization at individual-year level (calendar year), including individuals' annual visits for outpatients and annual discharges for inpatients. We also calculated herpes zoster individuals' annual outpatient (inpatient) cost burden by summarizing all of individual's herpes zoster and PHN costs for outpatient services (inpatient services) in the same calendar year. All cost-related variables have been adjusted to a 2019 comparable level using the Consumer Price Index.

Characteristics of the herpes zoster patients included age (under 45, 45–59, 60–74, and 75+), sex (male, female), residence (Beijing, non-Beijing) and PHN status (herpes zoster only, herpes zoster with PHN) and Payment methods. Payment methods was classified into Urban Employee Basic Medical Insurance (UEBMI), Urban and Rural Resident Basic Medical Insurance (URRBMI), Self-Pay (All by Out-of-pocket) and Others (such as medical aid). In China, UEBMI and URRBMI are two public health insurance schemes covering over 95 % of the population. UEBMI is designed for individuals with stable employment and URRBMI covers individuals who are not eligible for UEBMI. The reimbursement rate (as well as the deductible and ceilings of reimbursement) varies by regions and patient characteristics. In Beijing, UEBMI reimburses over 60 % of outpatient cost and over 80 % of inpatient costs. UEBMI also includes a health account for covering the copayment of the insured. URRBMI reimburses over 50 % of outpatient cost and over 70 % of inpatient costs.

2.3. Statistical analysis

Firstly, our study evaluated the cost burden, annual healthcare utilization and annual cost burden of herpes zoster for patients with different characteristics. Considering the substantial differences between herpes zoster only and PHN patients, we analyzed their cost burden separately. For analyzing annual health utilization and costs of patients with various characteristics, we employed demographic information at the time of their first visit or discharge in the year. In the analysis of annual utilization and cost, individuals who were diagnosed with post-herpetic neuralgia at least once across all visits or discharges within the same year were categorized as PHN patients.

To further explore the relationship between patients' characteristics and their cost burden, a series of log-linear regression models were constructed. The dependent variables comprised the cost per outpatient visit/inpatient discharge, LOS per hospitalization, the annual cost for outpatient/inpatient services, and the annual number of visits/discharges. Each dependent variable was logarithmically transformed

within the regression analysis. Independent variables encompassed patients' sex, age, residence, payment methods, and their status of PHN. To adjust for variations across years and hospitals, we incorporated yearly and hospital-level fixed-effects into the regression models. The software Stata version 17 for Windows (StataCorp, College Station, TX) was used for the statistical analysis.

3. Results

Fig. 1 illustrates an increasing temporal trend in the outpatient and inpatient healthcare utilization among patients with herpes zoster, with the notable exception of 2020, when the COVID-19 pandemic significantly impacted most regions in China. Across the selected 15 hospitals, the number of herpes zoster outpatient visits (individuals) rose by approximately 23.8 % (34.7 %) over the past eight years. While in 175 hospitals, the number of herpes zoster inpatient discharges (individuals) saw an increase of about 124.8 % (106.1 %) over the same period, and an increase of nearly 221.0 % (182.7 %) over the last eleven years. Concurrently, there has been a significant rise in the proportion of PHN visits (discharges)—by 24.2 percentage points for outpatient visits (from about 12.3 % to around 36.5 %) and 24.8 percentage points for inpatient discharges (from roughly 51.3 % to approximately 76.1 %).

Supplementary Table A.4 and Table A.5 shows more details of herpes zoster patients. In 2023, we observed 34,416 herpes zoster individuals in Beijing. Considering a population of 21.9 million permanent residents in Beijing (our data were assumed to cover 19.9 % of them, see Table A.1), adjusting for non-Beijing patients (24.2 %, see Table A.5) and assuming that all patients had at least one outpatient visit, the incidence rate was roughly estimated to exceed 6.0 per 1000 person-years (34,416 × (1–24.2 %) / (21.9 million*19.9 %) ≈ 6.0 ‰). Approximately 24.1 % (21.5 %) of herpes zoster outpatient visits (individuals) experienced PHN, whereas 62.0 % (59.7 %) of herpes zoster inpatient discharges (individuals) experienced PHN. A substantial minority of outpatient visits (23.6 % visits and 30.9 % individuals) were under the age of 45, compared to only 7.8 % (8.4 %) of inpatient visits (individuals) in the same age range. Approximately one-fifth of healthcare were used by those from outside of Beijing. Concerning payment for services, roughly 15 % of outpatient visits and inpatient discharges did not utilize China's basic medical insurance schemes (UEBMI and URRBMI).

As shown in Fig. 2, for herpes zoster outpatients, their average cost per visit fluctuated at 400 RMB (57 USD) over the past eight years, with approximately 20 % decrease to about 348 RMB (50 USD) for herpes zoster only cases and nearly 30 % increase to about 488 RMB (70 USD) for those accompanied with PHN. Concurrently, herpes zoster inpatients' average cost per discharge increased over 20 %, to around 13,514 RMB (1931 USD), with cost of herpes zoster only cases increased nearly 30 % to about 12,297 RMB (1757 USD). Over the same duration, number of annual outpatient visits slightly decreased for herpes zoster only patients (from 2.2 to 2.0) but that for PHN accompanied patients declined over 1/3 (from 4.3 to 2.8). During this period, the number of

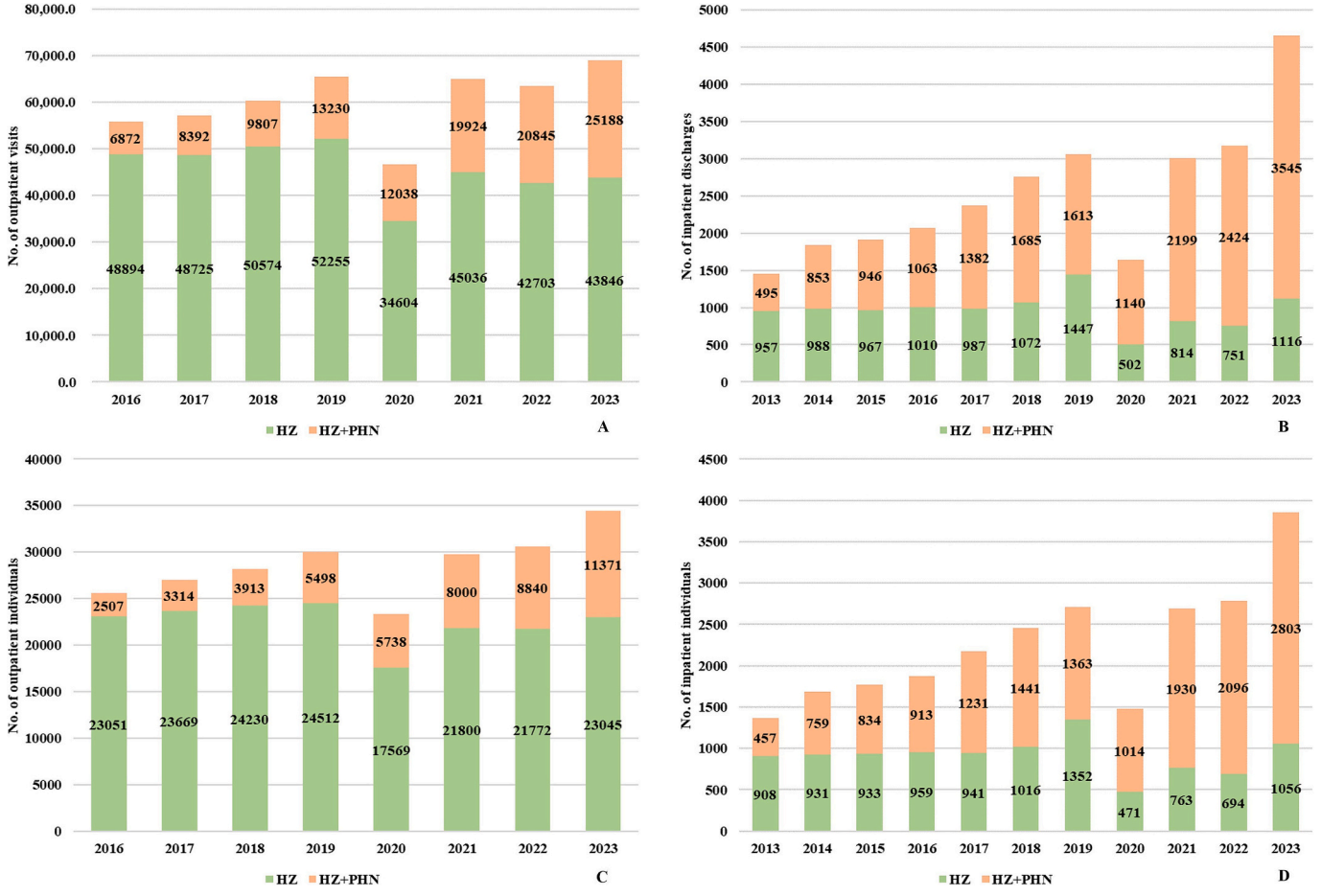

Fig. 1. Number of herpes zoster outpatients and inpatients in Beijing, 2013 to 2023. **Description:** Fig. 1 shows the number of herpes zoster outpatients in Beijing during 2016 to 2023 and the number of inpatients during 2013 to 2023. **Notes:** Outpatients from 15 hospitals and inpatients from 175 hospitals in Beijing were included. HZ, herpes zoster patients without post-herpetic neuralgia; HZ + PHN, herpes zoster patients with post-herpetic neuralgia. Fig. 1A, change of herpes zoster outpatient visits in 15 hospitals in Beijing. Fig. 1B, change of number of HZ inpatient discharges in 175 hospitals in Beijing, Fig. 1C, change of herpes zoster outpatient individuals in 15 hospitals in Beijing. Fig. 1D, change of number of HZ inpatient individuals in 175 hospitals in Beijing. For outpatient care, only data from 2016 to 2023 were included.

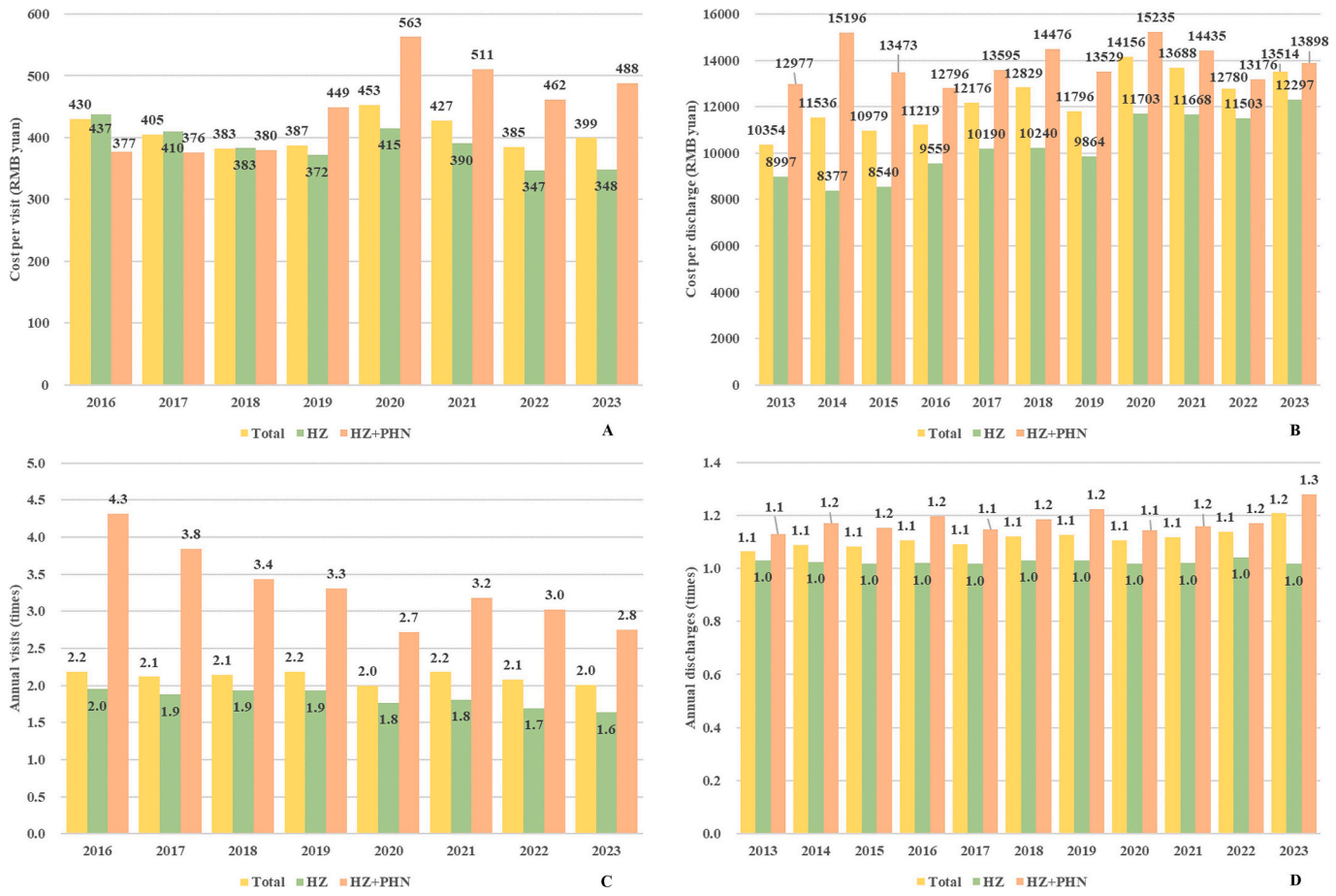

Fig. 2. Cost and annual visits/admissions of herpes zoster outpatients and inpatients in Beijing, 2013 to 2023. **Description:** Fig. 2 shows cost and annual visits of herpes zoster outpatients in Beijing during 2016 to 2023 and cost and annual admissions of herpes zoster inpatients during 2013 to 2023. **Notes:** Outpatients from 15 hospitals and inpatients from 175 hospitals in Beijing were included. HZ, herpes zoster patients without post-herpetic neuralgia; HZ + PHN, herpes zoster patients with post-herpetic neuralgia; Total, HZ-only patients and PHN accompanied patients. Fig. 2A, cost per visit of HZ outpatients in 15 hospitals in Beijing. Fig. 2B, cost per discharge of HZ inpatients in 175 hospitals in Beijing. Fig. 2C, annual visits per HZ outpatient individual in 15 hospitals in Beijing. Fig. 2D, annual discharges per HZ inpatient individual in 175 hospitals in Beijing. 1 USD ≈ 7 RMB. For outpatient care, only data from 2016 to 2023 were included.

annual hospital discharges increased from 1.1 to 1.3 times for PHN-accompanied patients. The annual cost was 798 RMB (114 USD) for herpes zoster outpatients and 16,323 RMB (2332 USD) for inpatients in 2023 (see Supplementary Table A.6).

As shown in Table 1, Table 2 and Table 3, the costs for cases with herpes zoster varied among different groups. Male cases exhibited a

Table 1
Cost of healthcare for patients with herpes zoster in Beijing, 2013 to 2023.

	Outpatient Care, Mean (SD)			Inpatient Care, Mean (SD)		
	Total	Herpes Zoster Only	Herpes Zoster with PHN	Total	Herpes Zoster Only	Herpes Zoster with PHN
Sex						
Male	405.4 (381.5)	384.1 (351.5)	471.4 (456.0)	12,568.3 (10,927.3)	10,108.0 (8294.6)	14,045.3 (11,999.2)
Female	408.0 (415.2)	390.5 (393.5)	463.4 (473.1)	12,406.4 (10,630.2)	10,208.5 (9019.8)	13,772.3 (11,305.3)
Age						
0–44	336.7 (330.0)	325.5 (308.7)	411.3 (438.7)	9143.4 (9244.2)	8856.1 (10,836.2)	9474.4 (6964.6)
45–59	393.5 (361.1)	381.8 (345.3)	441.9 (416.5)	10,670.1 (8913.5)	8728.5 (6831.5)	12,215.6 (10,008.9)
60–74	439.0 (436.7)	421.5 (416.8)	481.1 (478.6)	12,646.1 (10,181.2)	9957.9 (8041.6)	13,999.5 (10,854.8)
75+	460.3 (453.4)	441.7 (428.4)	492.6 (492.0)	14,421.6 (12,729.6)	12,245.4 (9649.0)	15,684.7 (14,061.9)
Residence						
Beijing	414.9 (406.5)	402.4 (387.8)	454.0 (458.1)	11,810.1 (9650.2)	10,036.1 (7858.3)	13,100.7 (10,583.1)
Non-Beijing	373.5 (374.8)	326.9 (314.8)	521.0 (492.8)	15,346.0 (14,258.8)	11,298.8 (14,105.9)	16,369.3 (14,116.3)
Payment						
UEBMI	409.4 (417.2)	386.7 (394.5)	475.3 (470.8)	12,001.8 (9935.0)	10,100.5 (7853.5)	13,260.9 (10,920.2)
URRBMI	458.6 (321.3)	465.3 (317.2)	383.4 (355.8)	12,930.3 (11,205.5)	9892.7 (9168.5)	14,825.6 (11,923.0)
Self-Pay	375.8 (352.4)	350.5 (303.3)	448.1 (457.1)	13,187.7 (13,469.3)	9628.3 (11,848.6)	14,870.3 (13,860.9)
Others	332.1 (360.1)	319.3 (338.3)	380.8 (430.0)	15,373.4 (13,763.2)	11,996.2 (13,401.2)	16,545.7 (13,696.8)

Notes: The cost per outpatient visits and cost per inpatient discharges were reported. PHN, post-herpetic neuralgia. UEBMI, urban employee basic medical insurance; URRBMI, urban and rural resident basic medical insurance. 1 USD ≈ 7 RMB. For outpatient care, only data from 2016 to 2023 were included.

Table 3
Annual utilization of healthcare for patients with herpes zoster in Beijing, 2013 to 2023.

	Outpatient Care, Mean (SD)			Inpatient Care, Mean (SD)		
	Total	Herpes Zoster Only	Herpes Zoster with PHN	Total	Herpes Zoster Only	Herpes Zoster with PHN
Sex						
Male	2.1 (3.2)	1.8 (1.8)	3.1 (5.7)	1.1 (0.5)	1.0 (0.2)	1.2 (0.6)
Female	2.1 (3.0)	1.9 (2.0)	3.2 (5.2)	1.1 (0.5)	1.0 (0.2)	1.2 (0.6)
Age						
0–44	1.6 (2.9)	1.5 (1.4)	2.3 (7.2)	1.0 (0.3)	1.0 (0.1)	1.1 (0.4)
45–59	2.0 (2.5)	1.8 (1.9)	2.8 (4.3)	1.1 (0.4)	1.0 (0.1)	1.1 (0.5)
60–74	2.5 (3.4)	2.1 (2.2)	3.4 (5.2)	1.1 (0.5)	1.0 (0.2)	1.2 (0.6)
75+	2.7 (3.7)	2.2 (2.4)	3.7 (5.1)	1.2 (0.6)	1.0 (0.3)	1.2 (0.7)
Residence						
Beijing	2.2 (3.3)	1.9 (2.1)	3.3 (5.8)	1.1 (0.5)	1.0 (0.2)	1.2 (0.6)
Non-Beijing	1.7 (2.1)	1.5 (1.2)	2.5 (3.9)	1.2 (0.5)	1.0 (0.4)	1.2 (0.6)
Payment						
UEBMI	2.2 (3.0)	1.9 (2.0)	3.3 (5.0)	1.1 (0.5)	1.0 (0.2)	1.2 (0.6)
URRBMI	2.3 (2.5)	2.3 (2.3)	3.0 (3.7)	1.1 (0.4)	1.0 (0.1)	1.1 (0.5)
Self-Pay	1.7 (3.7)	1.5 (1.3)	2.4 (7.3)	1.1 (0.4)	1.0 (0.2)	1.2 (0.5)
Others	1.7 (1.8)	1.5 (1.1)	2.4 (3.3)	1.1 (0.4)	1.0 (0.2)	1.1 (0.4)

Notes: The average number of herpes zoster individuals' annual outpatient visits and inpatient discharges within the same year was reported. PHN, post-herpetic neuralgia. Those who were ever diagnosed with post-herpetic neuralgia at least once within the same year were categorized into the PHN group. UEBMI, urban employee basic medical insurance; URRBMI, urban and rural resident basic medical insurance. For outpatient care, only data from 2016 to 2023 were included.

Table 2
Length of stay for patients with herpes zoster in Beijing, 2013 to 2023.

	Length of Stay, Mean (SD)		
	Total	Herpes Zoster Only	Herpes Zoster with PHN
Gender			
Male	9.3 (6.8)	10.5 (6.6)	8.5 (6.8)
Female	9.9 (7.2)	10.9 (6.6)	9.3 (7.4)
Age			
0–44	8.8 (5.6)	9.0 (5.4)	8.7 (5.9)
45–59	9.2 (5.8)	9.8 (5.3)	8.7 (6.1)
60–74	9.3 (6.6)	10.7 (6.1)	8.6 (6.8)
75+	10.8 (8.4)	12.4 (8.1)	9.8 (8.5)
Residence			
Beijing	9.9 (6.9)	10.8 (6.6)	9.2 (7.0)
Non-Beijing	8.6 (7.3)	10.1 (6.6)	8.2 (7.5)
Insurance			
UEBMI	9.7 (6.8)	10.9 (6.5)	8.9 (6.9)
URRBMI	9.9 (6.8)	10.1 (5.9)	9.7 (7.2)
Self-Pay	9.0 (7.9)	9.9 (6.0)	8.6 (8.6)
Others	9.3 (7.8)	11.0 (8.4)	8.7 (7.4)
Year			
2013	12.3 (8.1)	11.5 (7.1)	14.1 (9.5)
2014	12.6 (8.9)	11.2 (7.3)	14.2 (10.3)
2015	11.7 (6.8)	11.2 (6.7)	12.1 (6.8)
2016	11.3 (6.4)	11.3 (6.2)	11.3 (6.6)
2017	10.5 (6.2)	10.9 (6.0)	10.3 (6.3)
2018	10.3 (6.5)	10.6 (6.8)	10.2 (6.3)
2019	9.3 (6.2)	9.9 (5.2)	8.9 (6.9)
2020	9.4 (7.4)	10.6 (6.2)	8.9 (7.8)
2021	8.9 (6.9)	11.0 (6.8)	8.1 (6.8)
2022	7.9 (6.2)	10.6 (6.8)	7.1 (5.7)
2023	7.0 (6.4)	10.0 (7.1)	6.1 (5.8)

Notes: The length of stay per hospitalization was reported. PHN, post-herpetic neuralgia. UEBMI, urban employee basic medical insurance; URRBMI, urban and rural resident basic medical insurance.

higher cost per discharge (but slightly shorter LOS) and similar times of annual healthcare utilization to females. With increasing age, both the cost burden per visit/discharge, length of stay per hospitalization and annual healthcare utilization escalated. Notably, patients aged 75 or older incurred over 1.3 times (1.5 times) of the cost per visit (discharge) compared to those under 45. Compared to patients in Beijing, those from outside of Beijing, used less outpatient care but more hospitalizations. Those paying via URRBMI and UEBMI faced higher costs per visit but lower costs per discharge. The LOS decreased from 12.3 days in 2013 to 7 days in 2023.

The findings in Table 4 and the Supplementary Table A.7 indicate that, after controlling for other variables and considering fixed effects, female patients experienced a slightly lower annual outpatient cost but a slightly longer LOS per hospitalization compared to male patients. For the oldest group (75 or older), their average cost per visit was about 1/3 higher and the number of annual visits was 1/4 higher than the youngest group (under 45). Their average cost per discharge, LOS and the number of annual discharges were 40.8 %, 11.5 % and 5.3 % higher, respectively, than those of the youngest group. Patients residing outside Beijing incurred 10.0 % higher cost per hospitalization than their local counterparts. Furthermore, patients who covered by the URRBMI scheme and those opted for direct cash payment incurred 7.0 % and 10.9 % lower cost per outpatient visit, respectively, when contrasted to users of UEBMI. In terms of costs per discharge, those paid all by out-of-pocket spent 12.4 % less than UEBMI users. Patients with PHN, on average, exhibited 44.1 % more annual outpatient visits, 16.6 % higher cost per discharge, 11.8 shorter LOS and 9.3 % more annual inpatient discharges.

4. Discussion

In this study, with a large database containing eight-year outpatient data and eleven-year inpatient data, we analyzed the cost burden of herpes zoster patients' healthcare and their temporal trends. We found a relatively stable cost per herpes zoster outpatient visit and a slightly increasing cost per herpes zoster hospitalization. Moreover, with a pre-defined list of hospitals, we saw a rapid increase of the total volume of both herpes zoster outpatient and inpatient health care in the past eight years. Most of herpes zoster inpatients suffered PHN and the share of PHN accompanied outpatients was also increased.

Based on the assumption that all patients had at least one outpatient visit, the incidence rate was roughly estimated to exceed 6.0 per 1000 person-years. Our estimate aligns closely with the findings of a recent study conducted in the Yinzhou district of China, which reported an incidence rate of 6.64 per 1000 person-years between 2015 and 2017 (Sun et al., 2021). However, it is important to note that our estimate likely represents a lower bound, as a proportion of herpes zoster patients may not seek outpatient care, suggesting that the true incidence rate could be higher. Both our data and the Yinzhou study indicate a significantly higher incidence rate compared to an earlier survey-based study conducted in Beijing, which reported an incidence rate of approximately 2.0 per 1000 person-years(Lu et al., 2018). This discrepancy may reflect differences in study methodologies, population characteristics, or healthcare-seeking behaviors over time.

Although our descriptive results indicate that male patients incurred higher hospitalization costs, the regression analysis suggests that this cost difference was not statistically significant after controlling for patient age, residence, payment method, and PHN status. Our study reveals that outpatient costs for individuals covered by the URRBMI and those

Table 4
Regression analysis on healthcare utilization for herpes zoster patients in Beijing, 2013 to 2023.

	Outpatient Services				Inpatient Services					
	Cost per visit		Annual visits		Cost per discharge		Length of stay		Annual discharges	
	Diff. (%)	*P*-values	Diff. (%)	P-values	Diff. (%)	P-values	Diff. (%)	P-values	Diff. (%)	P-values
Sex										
Male	Ref.		Ref.		Ref.		Ref.		Ref.	
Female	−0.6	0.231	0.3	0.527	1.0	0.299	4.2	$P < 0.01$	0.4	0.340
Age										
0–44	Ref.		Ref.		Ref.		Ref.		Ref.	
45–59	16.4	$P < 0.01$	10.4	$P < 0.01$	15.3	$P < 0.01$	2.7	0.399	1.4	$P < 0.01$
60–74	27.6	$P < 0.01$	22.8	$P < 0.01$	28.7	$P < 0.01$	6.9	0.150	3.6	$P < 0.01$
75+	33.1	$P < 0.01$	25.2	$P < 0.01$	40.8	$P < 0.01$	11.5	0.026	5.3	$P < 0.01$
Residence										
Beijing	Ref.		Ref.		Ref.		Ref.		Ref.	
Non-Beijing	3.5	0.253	−4.0	0.026	10.0	$P < 0.01$	0.6	0.898	−1.0	0.329
Payment										
UEBMI	Ref.		Ref.		Ref.		Ref.		Ref.	
URRBMI	−7.0	0.019	−3.0	0.347	−0.1	0.971	−2.4	0.528	−1.9	0.021
Self-Pay	−10.9	$P < 0.01$	−15.5	$P < 0.01$	−12.4	0.040	−6.8	0.330	−0.4	0.572
Others	−8.9	0.060	−10.5	$P < 0.01$	−0.3	0.924	0.5	0.934	−2.7	$P < 0.01$
With PHN										
No	Ref.		Ref.		Ref.		Ref.		Ref.	
Yes	16.0	0.294	44.1	$P < 0.01$	16.6	$P < 0.01$	−11.8	0.062	9.3	$P < 0.01$
Fixed Effect										
Year	Controlled		Controlled		Controlled		Controlled		Controlled	
Hospital	Controlled		Controlled		Controlled		Controlled		Controlled	
Observations	475,675		228,829		27,928		27,928		24,839	

Notes: The difference (Diff.) represents the level of outcomes relative to the reference group in the regression model, with (exp(β) - 1) * 100 displayed in the table. PHN, post-herpetic neuralgia. UEBMI, urban employee basic medical insurance; URRBMI, urban and rural resident basic medical insurance. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Hospital-level clustered standard errors were calculated in each model. All dependent variables were transformed into their logarithmic forms in the model. For outpatient care, only data from 2016 to 2023 were included.

who self-pay are lower than for those covered by the UEBMI. We hypothesize that economic factors are the primary contributors to this disparity. Compared to URRBMI enrollees, UEBMI enrollees' deductible can be offset by their health insurance account.

In 2023, cost per herpes zoster outpatient visit averaged $57 and cost per herpes zoster hospitalization was about $1931. Our outpatient cost estimates are lower, but inpatient costs are higher when compared to the Yinzhou study(Sun et al., 2021), which reported costs of about $80 per outpatient visit and around $1160 per hospitalization. Given that over 30 % of the outpatient cases in our study were under 45 and the Yinzhou study focused on individuals aged 50 and older, we speculate that age differences are the primary factor influencing cost discrepancies in outpatient visits. Additionally, while the Yinzhou study tried to capture all healthcare utilization at the individual level, our calculation of costs at the individual-year level may underestimate expenses for those who utilized healthcare services over multiple years. Considering there was only small part of inpatient services used by the younger population and the broader variances of hospitalization cost across hospitals, the disease's severity and the hospital care intensity are likely the main contributors to these disparities in cost of hospitalization. Our research included patients from nearly all hospitals in Beijing, encompassing many individuals with severe disease conditions. Another study on the burden of herpes zoster, based on interviews and surveys, reported outpatient visit expenses averaging $78 and inpatient costs averaging $643, whose results of inpatient costs are much lower than the results of the Yinzhou study and our study(Li et al., 2016). Compared to the Yinzhou study and our study, Li's study analyzed costs based on self-reported survey data collected in community and village settings. In addition to recall bias, self-reported costs may omit expenses covered by health insurance (about 50 % of the cost), particularly given the well-developed real-time reimbursement system in China during their research period.

The annual costs in our study were $114 for herpes zoster outpatients and $2332 for herpes zoster inpatients, which are close to those found in a German study that reported annual costs of €82 and €186 for herpes zoster only and PHN outpatient services, and €2984 and €3738 for herpes zoster only and PHN hospitalization care(Ultsch et al., 2013). The German study's costs excluded costs related to drug prescription, therapeutic appliance and co-payment, while the total costs in our study encompass all relevant direct medical costs. Consequently, the real costs for herpes zoster in Germany are likely to exceed the aforementioned values. Although our results show a lower cost burden of herpes zoster than countries like Germany, it warrants greater attention of the cost burden of herpes zoster in China since the average income is much lower in China than that in developed countries.

The annual outpatient cost and individuals' annual outpatient visits for herpes zoster patients have decreased over the past eight years, whereas their annual inpatient costs and annual discharges have experienced a rising trend. We discerned a rapid growth in herpes zoster outpatients and an even more pronounced increase in herpes zoster inpatients. Over the past eight years, the LOS per hospitalization in Beijing has decreased (from 9.6 days to 7.8 days), while the cost per hospitalization increased (from about $3210 to $3285) (Beijing Municipal Health Big Data and Policy Research Center, 2025). This trend is also observed in hospitalizations for herpes zoster patients in our study. Hospitals in Beijing have reduced LOS to accommodate the growing demand for hospitalization services. Conditions with lower daily costs, such as herpes zoster, experienced a more pronounced decrease in LOS. Additionally, regulatory measures aimed at controlling cost increases, including reforms in payment methods such as the diagnosis-related group system, have contributed to these changes in LOS.

Furthermore, we observed a substantial rise in the portion of healthcare utilized by patients suffering from PHN, which is consistent with the results of a research in Sweden(Södergren et al., 2024). The improvement in living standards and health literacy among the population may have increased the demand for formal care among herpes zoster patients. However, we didn't find an increase in patients with mild herpes zoster symptoms with a decline in the cost per visit or discharge. We found that the number of herpes zoster only outpatients remained relatively stable compare to the pre-2020 levels and the

number of herpes zoster only inpatients even decreased. Given that costs for PHN patients are higher than those for herpes zoster only patients (Ultsch et al., 2013; Friesen et al., 2017; Rampakakis et al., 2017; Sun et al., 2021), this may suggest that the escalating number of patients with PHN could potentially be the main driver of the increased annual healthcare utilization associated with herpes zoster and may also serve as the principal obstacle impeding a reduction in costs.

Furthermore, our analysis underscores the significance of health financing security herpes zoster related healthcare utilization. In comparison to patients covered by UEBMI or URRBMI, those relying on out-of-pocket payments have a lower cost per visit and cost per discharge. This suggests that the capacity to pay remains a significant determinant of herpes zoster patients' healthcare utilization patterns. Our findings suggest that China is still in a phase where demand for herpes zoster healthcare is growing. As the population ages, the overall cost burden of herpes zoster is anticipated to escalate. Therefore, preventive efforts are expected to play a more critical role in mitigating the burden of herpes zoster on both individuals and the healthcare system(Martins et al., 2021). In China, two types of herpes zoster vaccines are available at local vaccination centers: the recombinant subunit vaccine (454 USD) and the live attenuated vaccine (194 USD). Both vaccines have been demonstrated to be cost-effective for the Chinese population(Wang et al., 2024).

The study has several limitations. First, this study couldn't include as much hospitals for outpatient analysis as we did for inpatient analysis. Despite we found a relatively stable share of outpatient visits of our predefined 15 hospitals compared to Beijing's total outpatient visits, the temporal change in the proportion of outpatients from outside Beijing within these hospitals might potentially skew our deduction regarding overall herpes zoster healthcare burden. Second, due to data limitations, we were unable to control for patients' chronic conditions and other potential factors in the regression analysis. Third, the definition of PHN, the public's awareness on PHN and the use of PHN code, might change during our research period, which may introduce bias into our analysis of PHN patients. Last, given Beijing's more advanced economic development and healthcare infrastructure compared to the rest of China, the study results may be skewed and not perfectly reflect the current cost burden at national level. However, insights derived from Beijing remain valuable, as cost analysis in this context may reduce biases arising from unmet healthcare needs and non-standardized management of herpes zoster. Our study can inform current policies in developed regions and provide guidance for future policy planning in less developed areas across China.

5. Conclusion

In this study, we assessed the cost burden related to outpatient and inpatient services for herpes zoster. Although the cost per outpatient visit and the cost per hospitalization changed little in the past eight years, a marked escalation in both herpes zoster outpatient visits and inpatient discharges were observed in a predefined group of hospitals. Due to the increase in the number of cases, even with similar costs per case, the overall cost burden has risen significantly. Older patients, those with more generous insurance scheme, and those suffering from PHN exhibited higher herpes zoster related costs and annual healthcare utilization. Our findings provide essential insights into the healthcare burden of herpes zoster and should be included in future health care policy planning and prevention strategies for herpes zoster.

CRediT authorship contribution statement

Zhenyu Shi: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Feng Lu:** Writing – review & editing, Writing – original draft, Resources, Data curation, Conceptualization. **Yiqi Xia:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Ping He:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Conceptualization.

Ethical approval

Approval was not required. All data have been anonymized and the analysis process is under full supervision by Beijing Municipal Health Big Data and Policy Research Center, ensuring no risk of personal information leakage. No further ethical approval for this type of study is required by Beijing Municipal Health Big Data and Policy Research Center.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Deepseek AI and Moonshot AI in order to improve the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2025.103046.

Data availability

Data are not publicly available and only available upon reasonable request and with permission of Beijing Municipal Health Big Data and Policy Research Center.

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