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Patient mobility and cross-regional care: patterns and associated factors based on 3.59 million inpatient records

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Abstract

Background: Cross-regional healthcare is a key issue affecting healthcare equity and resource allocation. Medical resources are unevenly distributed across the 'Beijing-Tianjin-Hebei' region, with Tianjin shouldering the dual responsibility of providing local medical care and alleviating pressure on Beijing's healthcare system.

Methods: In this cross-sectional study, data from the first pages of inpatient medical records at tertiary healthcare institutions across Beijing, Tianjin and Hebei for the period 2022-2023 were collected. Following data cleansing, 3,588,968 valid records were included in the analysis. Binary logistic regression and propensity score matching were employed to analyse the factors influencing patients' cross-regional healthcare-seeking behaviour.

Results: Among 2,147,400 inpatients in Tianjin, 46,643 sought treatment in Beijing and 3,826 in Hebei; the number of patients flowing into Tianjin was more than five times that of those flowing out. Male patients, younger patients, those in a relationship, retirees, those with commercial health insurance, and those planning readmission within 31 days were more likely to seek medical treatment outside their home region; patients with complex conditions, those in employment, and those not receiving poverty relief were more likely to travel to Beijing rather than Hebei. Healthcare service characteristics, such as hospitals on the recommended list, hospital tier, type, and economic status, had a significant net effect on the choice of treatment location.

Conclusions: Patient demographics and healthcare service utilization characteristics jointly influence the decisions of inpatients in Tianjin regarding seeking medical treatment outside their home region. In future, Tianjin needs to optimize the spatial distribution of medical resources, strengthen the development of medical disciplines, guide the establishment of a rational tiered diagnosis and treatment system, and enhance the standardization of regional healthcare services.

Background

Cross-regional healthcare refers to inpatient medical care received by a patient at a hospital in a province (excluding Hong Kong, Macao, and Taiwan) other than the province (autonomous region or municipality) where the patient resides [1]. Currently, this phenomenon has evolved from isolated cases into a significant public health issue affecting healthcare equity and the efficiency of health resource allocation.Prior to 2019, Thailand attracted approximately 3 million medical tourism patients annually; following the COVID-19 pandemic, the number of patients reached as high as 28 million in 2023, with 47 percent originating from high-income countries [2]. In response to the normalisation of cross-regional healthcare, Spain has signed more than 50 inter-regional healthcare cooperation agreements across its 17 autonomous communities over the past two decades [3]. In 2018, there were 65.32 million recorded instances of Chinese patients seeking medical treatment outside their home region; by 2022, this figure had surged to 110.5 million, with a high concentration in major cities and hospitals. Among these,

tertiary hospitals in Beijing and Shanghai accounted for 37.21 percent and 40.12 percent of inpatients seeking treatment from outside their home region respectively [4].

Patients' behaviour regarding seeking medical treatment in other regions is influenced by multiple factors; age, household income and health insurance all contribute to the demand for such care [5], with the imbalance in healthcare resources being the primary cause. Yang analysed the spatial transfer matrix of over 5.99 million inter-provincial inpatients in China in 2019 and found that the explanatory power of healthcare resource allocation [6], healthcare quality and healthcare costs for the inter-provincial inpatient flow network was respectively as high as 87%, 73% and 56%. The Beijing-Tianjin-Hebei region, comprising Beijing, Tianjin and Hebei, is a major political, economic and cultural centre in northern China. However, the distribution of healthcare resources within the region is extremely uneven, with the efficiency of healthcare resource allocation in Beijing significantly higher than that in Tianjin and Hebei [7]. The Beijing-Tianjin-Hebei healthcare coordination strategy focuses on deepening healthcare system reform and enhancing the standardisation of medical services [8], with Tianjin bearing the dual responsibility of meeting the healthcare needs of local patients and alleviating the pressure on Beijing to accommodate patients from other regions. Current research on cross-regional healthcare in the Beijing-Tianjin-Hebei region has been overly focused on the patient level, whilst neglecting the development of regional healthcare quality [9–11]. Consequently, this paper aims to investigate the current status and influencing factors of cross-regional healthcare in Tianjin, thereby providing theoretical support for improving the quality of healthcare services in Tianjin and promoting the coordinated development of healthcare in the Beijing-Tianjin-Hebei region, as well as offering a scientific basis for relevant policy formulation.

Methods

Data collection

This study collected information from the first pages of inpatient medical records at tertiary healthcare institutions in the Beijing-Tianjin-Hebei region for the period 2022–2023. The dataset comprised information on local Tianjin patients and out-of-town patients visiting Tianjin collected from the Tianjin Hospital Quality Monitoring System; information on inpatients in Beijing whose current addresses were in Tianjin or Hebei, collected from the Beijing Comprehensive Health Statistics Platform; and information on inpatients in Hebei whose current addresses were in Tianjin, collected from the Hebei Health Statistics Online Direct Reporting System. A total of 4,426,437 inpatient records from tertiary hospitals across the three regions were provided; after excluding meaningless and incomplete entries, a final valid sample of 3,588,968 records was included (Fig. 1). Of these, 2,147,400 were patients seeking medical treatment locally in Tianjin; 3,826 were from Tianjin seeking treatment in Hebei; 46643 were from Tianjin seeking treatment in Beijing; 3,389 were from Beijing seeking treatment in Tianjin; 257,532 were from Hebei seeking treatment in Tianjin; 305,346 were from other regions seeking treatment in Tianjin; and 824,832 were from Hebei seeking treatment in Beijing. This study was approved by the Tsinghua University Medical Ethics Committee (IRB number: THU-01-2026-0064).

Figure 1: **Data cleaning process**

Notes: There were a total of 4,426,437 inpatient records from tertiary hospitals; after data cleaning, 3,588,968 valid records were ultimately included in the sample.

Using the CNKI, Wanfang, Weipu, Web of Science and PubMed databases as data sources, we constructed Boolean search queries to screen articles focusing on keywords such as 'Cross-regional medical treatment', 'patient mobility', 'cross-border medical treatment' and 'inter-provincial medical treatment', thereby systematically identifying the factors influencing Cross-regional medical treatment (Fig. 2). Information extraction from the 21 included studies revealed that the behaviour of seeking medical treatment in other regions is jointly influenced by patients' demographic characteristics and the characteristics of healthcare services. Consequently, this study selected six patient characteristic variables: predisposing factors (age, gender, marital status), facilitating factors (occupation, method of healthcare payment) and need-related factors (complexity of illness). As well as variables covering healthcare infrastructure (hospital tier, economic type of hospital, hospital type, whether the hospital is listed in the national ranking), process (name of the primary surgical procedure, department of discharge, name of the primary discharge diagnosis, whether surgery was performed, level of the primary surgical procedure, length of hospital stay) and outcome (wound healing grade of the primary surgical procedure, mode of discharge, total hospitalisation costs, and whether readmission was planned within 31 days of discharge). Due to limitations of the Hebei Province data platform, five surgery-related variables of disease complexity, name of surgical procedure, whether surgery was performed, surgical procedure level, and wound healing grade were missing for patients from Tianjin admitted to hospitals in Hebei.

Figure 2: **Literature search and screening process**

Notes: Using Boolean search queries, 792 relevant articles were retrieved from six databases; after deduplication and review by two researchers, 21 articles were ultimately included.

Statistical Analysis

In this study, continuous variables such as age, length of hospital stay and total hospital costs were found to be non-normally distributed following statistical tests. Therefore, the Mann-Whitney U test was used to compare the two groups, whilst categorical variables were analysed using the chi-square test. The dependent variables were categorised into two groups: local healthcare in Tianjin versus healthcare in Beijing, and local healthcare in Tianjin versus healthcare in Hebei. To further analyse the extent to which patient characteristics and healthcare service characteristics influence the behaviour of seeking medical treatment in other regions, three logistic regression models were constructed by incorporating variables found to be statistically significant in univariate analyses for each category. Model 1 included only patient characteristics; Model 2 included only healthcare service utilisation characteristics; and Model 3 included all dimensions. The goodness of fit of the models was assessed using the likelihood ratio test, as well as AIC and BIC values. To address the issue of sample imbalance caused by the

significantly larger sample size for local healthcare compared to Cross-regional healthcare, and to control for confounding bias, propensity score matching was further applied. Using six patient characteristics(age, gender, marital status, occupation, method of healthcare payment, complexity of illness) as matching variables, we performed nearest-neighbor matching on two pairs of patient groups, patients seeking medical care locally in Tianjin versus those traveling to Beijing for treatment, and patients seeking medical care locally in Tianjin versus those traveling to Hebei for treatment, at a 3:1 ratio between the local and out-of-area groups. Following matching, conditional logistic regression was conducted to estimate the net effect of healthcare service characteristics on the choice to seek treatment out of region. Data analysis was performed using R4.3.3 and Python3.12.3, with a two-sided significance level set at $\alpha = 0.05$.

Results

Patterns of Cross-regional Healthcare Seeking in Tianjin

Between 2022 and 2023, there were 2.147 million inpatient admissions at local tertiary hospitals in Tianjin, whilst 50,000 patients sought treatment elsewhere during the same period, patients receiving treatment locally constituted the overwhelming majority. Among outbound patients, the number travelling from Tianjin to Beijing was 12 times that travelling to Hebei, indicating that Beijing exerts a very strong medical influence on Tianjin. At the same time, the number of inbound patients to Tianjin was more than five times that of outbound patients, of these, 258000 patient visits were from Hebei, far exceeding those from Beijing. This suggests that Tianjin possesses a certain degree of regional medical appeal, but its reverse pull on patients from Beijing remains relatively weak.In terms of demographic characteristics, the median age of patients seeking treatment locally in Tianjin was relatively high, whilst those travelling to Beijing were predominantly younger working-age individuals, and those travelling to Hebei were mostly retired persons, suggesting a clear segmentation of patients according to their destination. Regarding healthcare service characteristics, Grade-A tertiary hospitals admitted the vast majority of patients across all groups, and patients travelling from Tianjin to Beijing had a higher demand for surgical procedures (Table 1).

Table 1
Descriptive statistics for patients seeking treatment locally in Tianjin, in Hebei and in Beijing

Variables[a]	Local patients in Tianjin	Patients from Tianjin to Hebei	Patients from Tianjin to Beijing
	(N = 2,147,400)	(N = 3,826)	(N = 46,643)
Gender			
Male	1,083,897 (50.48%)	1,997 (52.20%)	24,356 (52.22%)
Female	1,063,503 (49.52%)	1,829 (47.80%)	22,287 (47.78%)
Age	60 (40, 69)	49 (34, 61)	44 (30, 60)
Marital status			
Married	1,658,791 (77.25%)	2,996 (78.31%)	34,238 (73.40%)
Single	488,609 (22.75%)	830 (21.69%)	12,405 (25.60%)
Occupation			
Unemployed	156,227 (7.28%)	539 (14.09%)	2,125 (4.56%)
Student	45,607 (2.12%)	223 (5.83%)	4,060 (8.70%)
Retired	470,671 (21.92%)	1987 (51.93%)	5,519 (11.83%)
Employed	1,474,895 (68.68%)	1077 (28.15%)	34,939 (74.91%)
Healthcare payment methods			
Fully self-funded	165,218 (7.69%)	687 (17.96%)	7,084 (15.19%)
Urban Employee Medical Insurance	1,103,932 (51.41%)	1,287 (33.64%)	24,114 (51.70%)
Urban and Rural Residents' Medical Insurance	677,316 (31.54%)	1,058 (27.65%)	8904 (19.09%)
Commercial insurance	1,447 (0.07%)	28 (0.73%)	71 (0.15%)
Poverty relief	1552 (0.07%)	5 (0.13%)	5 (0.01%)
Other insurance	197,935 (9.22%)	761 (19.89%)	6,465 (13.86%)
Complexity of illness[b]			
Complex	412,039 (19.19%)	-	7,124 (15.27%)
Moderate	1,735,361 (80.81%)	-	39,519 (84.73%)
Hospital Characteristics			
By reputation[c]			

Variables[a]	Local patients in Tianjin	Patients from Tianjin to Hebei	Patients from Tianjin to Beijing
	(N = 2,147,400)	(N = 3,826)	(N = 46,643)
brand-name	293,396 (13.66%)	100 (2.61%)	22,464 (48.16%)
non-branded	1,854,004 (86.34%)	3,726 (97.39%)	24,179 (51.84%)
By grade			
Grade-A tertiary	1,873,410 (87.24%)	2,374 (62.05%)	37,898 (81.25%)
Grade-B tertiary	100,661 (4.69%)	17 (0.44%)	3 (0.01%)
Unrated Tertiary Hospital	173,329 (8.07%)	1,435 (37.51%)	8,742 (18.74%)
By specialty			
General hospitals	1,339,511 (62.38%)	3,181 (83.14%)	30,325 (65.02%)
Traditional Chinese Medicine hospitals	66,664 (3.10%)	33 (0.86%)	1,144 (2.45%)
Integrated Chinese and Western Medicine Hospitals	13,656 (0.64%)	11 (2.90%)	1,249 (2.68%)
Specialist hospitals	726,083 (33.81%)	493 (12.89%)	13,687 (29.34%)
Other hospitals	1,486 (0.07%)	8 (0.21%)	238 (0.51%)
By ownership			
Private	11,287 (0.53%)	149 (3.89%)	2,465 (5.28%)
Public	2,136,113 (99.47%)	3,677 (96.11%)	44,178 (94.72%)
Whether surgery was performed			
Surgery	714,753 (33.28%)	-	20,816 (44.63%)
No surgery	1,432,647 (66.72%)	-	25,827 (55.37%)
Primary surgical procedure level[d]			
No surgery or Grade-I/II surgery	1,505,171 (70.09%)	-	29,290 (62.80%)
Grade-□ surgery	405,420 (18.88%)	-	8,711 (18.68%)
Grade-□ surgery	236,809 (11.03%)	-	8,642 (18.53%)
Length of inpatient			
Continuous variables	5 (2, 8)	6 (3, 10)	4 (1, 8)
Incision healing grade following major surgical procedures			

Variables[a]	Local patients in Tianjin	Patients from Tianjin to Hebei	Patients from Tianjin to Beijing
	(N = 2,147,400)	(N = 3,826)	(N = 46,643)
No surgery or incision	1413242 (65.81%)	-	26,058 (55.87%)
Good healing	725,442 (33.78%)	-	19,526 (41.86%)
Poor healing	8,716 (0.41%)	-	1,059 (2.27%)
Discharge status			
Death	14,418 (0.67%)	24 (0.63%)	155 (0.33%)
Discharged or transferred on medical advice	1,787,988 (83.26%)	3,181 (83.14%)	45,778 (98.15%)
Discharged without medical authorisation	316,978 (14.76%)	604 (15.79%)	644 (1.38%)
Other	28,016 (1.30%)	17 (0.44%)	66 (0.14%)
Plans for readmission within 31 days of discharge			
Yes	227,479 (10.59%)	172 (30.63%)	9,229 (19.79%)
No	1,919,921 (89.41%)	2,654 (69.37%)	37,414 (80.21%)
Total hospitalisation costs	10902(6,595, 19,549)	8,580 (4,650, 16,062)	13,549.07 (6435, 31662)

a. Categorical variables are described using frequencies and percentages. Since the continuous variables (Age, Total hospitalization costs, Length of inpatient) are all non-normally distributed, they are described using medians and interquartile ranges.

b. Patients with > 9 comorbidities are considered to have complex diseases.

c. “Brand-name hospitals” are those listed in the Fudan University “2023 National Comprehensive Hospital Rankings” or the “2023 China Hospital Specialty Reputation Rankings,” which are authoritative rankings of Chinese medical institutions.

d.Based on the surgical procedure code database used for performance monitoring of public hospitals.

In terms of spatial distribution, patients from Tianjin travelling to Beijing are highly concentrated in Wuqing District and the central urban area, which border Beijing; those travelling to Hebei generally show a decreasing trend from south to north, primarily originating from Jinghai District and Binhai New District, which border Hebei (Fig. 3). The ranking of hospital admissions indicates that Tianjin’s departments with a comparative advantage in treating out-of-town patients are oncology, haematology and ophthalmology; Tianjin patients seeking treatment in Beijing are concentrated in the departments of Oncology, Obstetrics and Gynaecology, and Orthopaedics (Table 2), with the main conditions being malignant tumours, cataracts and angina pectoris (Table 3); patients travelling to Hebei, on the other

hand, are concentrated in Orthopaedics and Obstetrics and Gynaecology, primarily for fractures, arthritis and common obstetric conditions, and they mostly choose unrated or general hospitals in Hebei rather than top-tier Grade-A tertiary hospitals.

Figure 3: **Map of Tianjin showing the origins of patients from various districts travelling to Beijing and Hebei for medical treatment between 2022 and 2023**

Notes: The map is drawn to scale based on the actual geographical area and shows the names of each district. The central area includes Hongqiao District, Hebei District, Hedong District, Hexi District, Heping District, and Nankai District. The shades of color indicating the number of patients from that district travelling to Beijing and Hebei for medical treatment.

Table 2
Top 10 Departments by Inpatient Volume

Rank[a]	Local patients in Tianjin		Patients from Tianjin to Beijing		Patients from Tianjin to Hebei	
	Department	**n**	**Department**	**n**	**Department**	**n**
1	Cardiology	230126	Oncology	7244	Orthopaedics	557
2	Oncology	216936	Obstetrics and Gynaecology	4671	Obstetrics and Gynaecology	396
3	Obstetrics and Gynaecology	158195	Orthopaedics	3535	Oncology	304
4	Traditional Chinese Medicine	155523	General Surgery	2900	Ophthalmology	292
5	Paediatrics	139545	Paediatrics	2862	Traditional Chinese Medicine	240
6	General Surgery	134524	Ophthalmology	2860	Cardiovascular Medicine	204
7	Neurology	128006	Traditional Chinese Medicine	1931	General Surgery	192
8	Orthopaedics	123503	Cardiovascular Medicine	1857	Neurology	179
9	Ophthalmology	116093	Urology	1518	Otorhinolaryngology	162
10	Gastroenterology	72388	Neurosurgery	1267	Respiratory Medicine	112

a.Based on the codes entered by the hospital without manual intervention.

Table 3
Top 10 Diseases by Inpatient Volume and ICD Codes

Rank[a]	Local patients in Tianjin		Patients from Tianjin to Beijing		Patients from Tianjin to Hebei	
	Diagnosis	**n**	**Diagnosis**	**n**	**Diagnosis**	**n**
1	Angina pectoris(I20)	113766	Angina pectoris(I20)	122	Myasthenia gravis and other neuromuscular disorders(G70)	166
2	Cerebral infarction(I63)	101387	Fertility issues(N97)	816	Breast cancer(C50)	29
3	Pneumonia, unspecified pathogen(J18)	76017	Malignant tumours of the bronchi and lungs(C34)	673	Pneumonia, unspecified pathogen(J18)	107
4	Age-related cataracts(H25)	58371	Malignant tumour of the thyroid(C73)	519	Chronic ischaemic heart disease(I25)	100
5	Non-insulin-dependent diabetes mellitus(E11)	53001	Age-related cataracts(H25)	498	Non-insulin-dependent diabetes mellitus(E11)	87
6	Bacterial pneumonia, not elsewhere classified(J15)	40394	Other specific examinations and investigations undertaken in the absence of a chief complaint or diagnostic report(Z01)	470	Dizziness and vertigo(R42)	80
7	Acute myocardial infarction(I21)	36987	Other orthopaedic follow-up care(Z47)	468	Cerebral infarction(I63)	79
8	Chronic ischaemic heart disease(I25)	30764	Female genital tract polyps(N84)	466	Other orthopaedic follow-up care(Z47)	78
9	Heart failure(I50)	28349	Other retinal disorders(H35)	400	Other cerebrovascular diseases(I67)	58
10	Other retinal disorders(H35)	27709	Medical care involving rehabilitation procedures(Z50)	398	Malignant tumours of the bronchi and lungs(C34)	56

a.Using the Chinese National Clinical Version 2.0 of the International Classification of Diseases, 10th Revision (ICD-10) disease codes and the corresponding diagnostic names

Factors affecting Cross-regional healthcare for patients in Tianjin

Meta-analyses have found that the factors influencing Cross-regional healthcare-seeking behaviour encompass individual demographic and sociological factors, regional resource development indicators, and healthcare metrics, including individual demographic characteristics [12], social structural attributes [13], access to healthcare services and health status [14–16], as well as regional health policies [17], length of hospital stay [18], and distance to healthcare facilities [19], among other factors. These factors influence patients' decisions to seek medical treatment outside their local area by affecting their ability to access healthcare resources, the financial and non-financial burdens of seeking treatment, and the urgency of their medical needs.

In the univariate analysis of factors influencing Tianjin patients' choice between seeking local treatment and seeking treatment in Beijing or Hebei, the P-values for all variables were less than 0.001, and all variables were included in a binary logistic regression analysis. Upon comparing the AIC and BIC values of the three models, the comprehensive Model 3 was identified as the optimal model (Table 4). The results show that Tianjin patients who are male, younger, in a relationship, retired, covered by commercial health insurance, or planning a readmission within 31 days are more likely to choose Cross-regional healthcare rather than local care; whereas those with complex conditions, who are employed, and who do not receive poverty relief subsidies are more likely to seek treatment in Beijing rather than Hebei.

Table 4
Results of the binary logistic regression analysing Tianjin patients' choice of seeking medical treatment in Beijing, Hebei or locally (Model 3)

Variables[a]	**Local patients VS Patients to Beijing**[b]	**Local patients VS Patients to Hebei**[c]
	OR (95% CI)	**OR (95% CI)**
Gender (female = 0)		
Male	1.04 (1.02, 1.06)	1.43 (1.34, 1.53)**
Age	0.96 (0.96, 0.97)**	0.95 (0.95, 0.95)**
Marital status (single = 0)		
Married	1.46 (1.41, 1.51)**	3.54 (3.11, 4.02)**
Occupation (unemployed = 0)		
Student	3.74 (3.52, 3.99)**	1.01 (0.85, 1.20)
Retired	1.42 (1.34, 1.50)**	6.28 (5.59, 7.07)**
Employed	1.22 (1.17, 1.28)**	0.27 (0.24, 0.30)**
Healthcare payment method (fully self-funded = 0)		
Urban Employee Medical Insurance	0.64 (0.62, 0.66)**	0.23 (0.21, 0.25)**
Urban and Rural Residents' Medical Insurance	0.4 (0.39, 0.41)**	0.66 (0.59, 0.73)**
Commercial insurance	5.43 (4.04, 7.30)**	8.1 (4.71, 13.26)**
Poverty relief	0.07 (0.03, 0.16)**	1.19 (0.42, 2.61)
Other insurance	1.53(1.47, 1.59)	1.72 (1.54, 1.91)**
Disease complexity (uncomplicated = 0)		
Complex	1.17 (1.13, 1.20)**	-
Hospital Characteristics		
By reputation(non-branded = 0)		
brand-name	10.45 (10.15, 10.74)**	0.6 (0.49, 0.73)**
By grade (Grade-A tertiary = 0)		
Grade-B tertiary	<0.01 (< 0.01, 0.01)**	0.12 (0.07, 0.18)**
Unrated Tertiary Hospital	4.76 (4.61, 4.92)**	5.25 (4.88, 5.64)**
By specialty (General hospital = 0)		

Variables[a]	Local patients VS Patients to Beijing[b]	Local patients VS Patients to Hebei[c]
	OR (95% CI)	OR (95% CI)
Traditional Chinese Medicine hospital	0.79 (0.74, 0.85)**	0.05 (0.03, 0.07)**
Integrated Chinese and Western Medicine Hospital	4.8 (4.45, 5.17)**	2.27 (1.84, 2.80)**
Specialist hospital	1.53 (1.49, 1.57)**	0.14 (0.13, 0.16)**
Other hospitals	7.64 (6.52, 8.96)**	0.41 (0.20, 0.84)*
By ownership (private = 0)		
Public	0.13 (0.12, 0.14)**	0.32 (0.27, 0.39)**
Whether surgery was performed (no surgery = 0)		
Surgery	0.43 (0.41, 0.45)**	-
Primary surgical procedure level (no surgery or Grade-I/II surgery = 0)		
Grade-Ⅲ surgery	3.55 (3.41, 3.70)**	-
Grade-Ⅳ surgery	7.29 (6.98, 7.62)**	-
Length of inpatient	0.98 (0.98, 0.98)**	1.01 (1.01, 1.01)**
Grade of wound healing following major surgical procedures (no surgery or no incision = 0)		
Good healing	1.17 (1.13, 1.21)**	-
Poor healing	19.63 (17.94, 21.48)**	-
Discharge status (death = 0)		
Discharged on medical advice or transferred to another hospital	1.95 (1.64, 2.31)**	0.58 (0.38, 0.87)**
Discharge without medical advice	0.16 (0.13, 0.19)	0.74 (0.49, 1.13)
Other	0.337 (0.25, 0.46)	0.32 (0.17, 0.61)**
Whether there are plans for readmission within 31 days of discharge (none = 0)		
Yes	2.78 (2.71, 2.86)**	3.73 (3.46, 4.01)**
Total hospitalisation costs	1.04 (1.02, 1.06)**	1.00(0.99, 1.00)**

Variables[a]	Local patients VS Patients to Beijing[b]	Local patients VS Patients to Hebei[c]
	OR (95% CI)	OR (95% CI)
*p < 0.05, **p < 0.001		
a.The dependent variables were divided into two groups: those receiving treatment locally in Tianjin versus those traveling to Beijing for treatment, and those receiving treatment locally in Tianjin versus those traveling to Hebei for treatment. Multivariate analysis was performed using logistic regression, with Age, Total hospitalization costs, and Length of inpatient stay as continuous variables, and the following categorical variables coded as 0 for the reference category: female, single, unemployed, fully self-funded, uncomplicated disease, non-branded hospital, Grade-A tertiary hospital, general hospital, private hospital, no surgery performed, no surgery or Grade I/II surgery, no surgery or no incision, death, and no plans for readmission within 31 days of discharge.		
b. This model includes all variables; compared to Model 2, the likelihood ratio chi-square test p-value is < 0.001, with an AIC of 345,148 and a BIC of 345,551.		
c. This model includes all variables; compared to Model 2, the likelihood ratio chi-square test p-value is < 0.001, with an AIC of 29,961 and a BIC of 30,211.		

Net Effects of Healthcare Service Characteristics

After controlling for patient characteristic confounders using propensity score matching, balance tests showed that the means of the patient characteristic variables were close after matching, indicating a high quality of matching. The results of the conditional logistic regression further confirmed that healthcare service characteristics, such as brand-name hospitals, hospital tier, hospital type and hospital ownership, have a significant net effect on whether patients from Tianjin choose to seek medical treatment outside their home region. Furthermore, there are marked differences in the driving mechanisms behind seeking treatment in Beijing versus Hebei (Table 5). Patients from Tianjin travelling to Beijing were more likely to choose brand-name hospitals, private hospitals and hospitals with a high surgical grade. Compared with patients travelling to Hebei, this group typically had shorter hospital stays, higher total hospitalisation costs and outcomes that were predominantly discharge on medical advice or transfer to another hospital. Conversely, Tianjin patients who chose non-branded hospitals, such as qualified or unrated hospitals and general hospitals, had a significantly higher probability of seeking treatment in Hebei.

Table 5
Results of conditional logistic regression on the net effects of healthcare service characteristics

Variables[a]	**Local patients VS Patients to Beijing**	**Local patients VS Patients to Hebei**
	OR (95% CI)	**OR (95% CI)**
Hospital Characteristics		
By reputation(non-branded = 0)		
brand-name	3.10(2.83, 3.40)**	0.23 (0.18, 0.30)**
By grade (Grade-A tertiary = 0)		
Grade-B tertiary	0.01 (< 0.01, 0.03)**	0.14 (0.08, 0.24)**
Unrated Tertiary Hospital	6.79 (5.99, 7.71)**	3.65 (3.17, 4.21)**
By specialty (General hospital = 0)		
Traditional Chinese Medicine hospital	0.11 (0.10, 0.13)**	0.01 (0.01, 0.02)**
Integrated Chinese and Western Medicine Hospital	1.16 (0.95, 1.40)	1.08 (0.77, 1.50)
Specialist hospitals	0.63 (0.57, 0.70)**	0.17 (0.14, 0.20)**
Other hospitals	119.69 (42.70, 335.53)**	0.26 (0.09, 0.75)*
By ownership (private = 0)		
Public	0.02 (0.01, 0.03)**	0.08 (0.02, 0.30)**
Whether surgery was performed (no surgery = 0)		
Surgery	0.67 (0.56, 0.81)**	-
Primary surgical procedure level (no surgery or Grade-I/II surgery = 0)		
Grade-Ⅲ surgery	2.74 (2.27, 3.31)**	-
Grade-Ⅳ surgery	2.98 (2.39, 3.71)**	-
Length of inpatient	1.00 (0.99, 1.00)*	1.01 (1.00, 1.01)**
*p < 0.05, **p < 0.001		
a.Logistic regression analysis was performed, with Total hospitalization costs and Length of inpatient stay as continuous variables, and the following categorical variables coded as 0 for the reference category: non-branded hospital, Grade-A tertiary hospital, general hospital, private hospital, no surgery performed, no surgery or Grade I/II surgery, no surgery or no incision, death, and no plans for readmission within 31 days of discharge		

Variables[a]	Local patients VS Patients to Beijing	Local patients VS Patients to Hebei
	OR (95% CI)	OR (95% CI)
Grade of wound healing following major surgical procedures (no surgery or no incision = 0)		
Good healing	1.03 (0.85, 1.26)	-
Poor healing	25.16 (7.41, 85.35)**	-
Discharge status (death = 0)		
Discharged on medical advice or transferred to another hospital	2.28 (1.35, 3.87)**	0.98 (0.43, 2.25)
Discharge not on medical advice	0.40 (0.23, 0.71)**	2.29 (0.98, 5.37)
Other	0.68 (0.31, 1.48)	0.60 (0.20, 1.80)
Plans for readmission within 31 days of discharge (no = 0)		
Yes	1.19 (1.04, 1.37)*	1.69 (1.49, 11.91)**
Total hospitalisation costs	1.10 (1.05, 1.15)**	1.00 (0.99, 1.00)**
*p < 0.05, **p < 0.001		
a.Logistic regression analysis was performed, with Total hospitalization costs and Length of inpatient stay as continuous variables, and the following categorical variables coded as 0 for the reference category: non-branded hospital, Grade-A tertiary hospital, general hospital, private hospital, no surgery performed, no surgery or Grade I/II surgery, no surgery or no incision, death, and no plans for readmission within 31 days of discharge		

Discussion

Wuqing District, which borders Beijing, and the central urban area with its convenient transport links and affluent residents are the primary sources of patients travelling to Beijing for medical treatment. Jinghai and Binhai New District, which border Hebei, constitute the main sources of patients travelling to Hebei for medical treatment. Administrative districts surrounding the central urban area, which do not border other provinces and have relatively inconvenient transport links, experience a lower outflow of patients. This is consistent with the view put forward by Ding [19] that patient flow declines significantly with increasing distance. Location and transport infrastructure are key drivers of patient outflow from Tianjin's various districts to other regions, however, at its core, this phenomenon stems from an imbalance in the spatial distribution of healthcare facilities. Currently, the majority of Tianjin's 45 tertiary hospitals are concentrated in the central urban area, whilst the outlying districts and counties are predominantly served by primary-care hospitals with a lower density of resources [20]. Optimising the overall layout of healthcare facilities and enhancing the infrastructure and diagnostic and treatment

capabilities in the outlying districts and counties are of great significance for improving the quality of healthcare services in Tianjin. The regional medical centre landscape should be reshaped through 'one hospital, multiple campuses' models such as joint construction, in-depth cooperation, mergers and trusteeship, to reduce the cross-regional movement of patients with common ailments [21]. On this basis, Tianjin should dispatch training groups to Beijing and Hebei, conduct regular assessments and establish reward and penalty mechanisms, and formulate performance allocation mechanisms suitable for multi-campus hospitals using comprehensive, multi-dimensional medical evaluation indicators, thereby enhancing cultural identity across all campuses [22]. At the same time, the digital information platform and telemedicine system should be improved to break down information barriers between regional medical institutions. Through the sharing of laboratory and diagnostic test results, the circulation of electronic prescriptions and remote consultations, the capacity of primary care facilities to manage patients and access to healthcare should be strengthened [23].

Tianjin's key departments for out-of-town patients are oncology, haematology and ophthalmology. In the future, Tianjin needs to continue to consolidate the leading position of its key disciplines across multiple areas [24], including clinical diagnostic and treatment capabilities, scientific research and innovation, talent development and teaching implementation. By building on the existing National Regional Cancer Medical Centre, the city should establish national specialist brands such as the Tianjin Cancer Hospital and deepen cooperation with top-tier Grade-A tertiary hospitals such as the Institute of Haematology, Chinese Academy of Medical Sciences [25], and promote the in-depth development of high-end ophthalmology sub-specialities and the decentralisation of treatment protocols to further consolidate regional competitiveness. Meanwhile, the concentration of patients travelling from Tianjin to Beijing and Hebei for obstetrics and gynaecology and orthopaedics indicates that Tianjin still has significant shortcomings in these areas. By establishing closely integrated medical consortia [26], forming specialist alliances [27], and introducing high-calibre talent and cutting-edge technologies and other measures to rapidly enhance specialist diagnostic and treatment capabilities [28]. For example, through collaboration with Beijing Jishuitan Hospital and the Third Hospital of Hebei Medical University, efforts are being made to promote the development of orthopaedic specialist alliances [29], transforming their orthopaedic expertise into replicable, standardised models. This aims to improve the medical service capabilities and management standards of member institutions, facilitate the decentralisation of high-quality medical resources, and achieve a uniform improvement in regional diagnostic and treatment standards [30].

The group seeking medical treatment away from their home region is predominantly male, younger, in a relationship, retired and covered by private health insurance; this is highly consistent with the findings of previous studies both in China and abroad [31, 32]. This demographic possesses greater capacity to seek medical treatment in other regions and enjoys a higher socio-economic status; their partners are able to provide comprehensive care support throughout the process, and they can completely avoid conflicts between work commitments and the time required for Cross-regional healthcare. In contrast, vulnerable groups such as the elderly and the unemployed tend to have poorer physical functioning and limited financial resources, meaning their healthcare needs are largely confined to local medical

institutions. In response, Tianjin needs to further optimise the end-to-end support mechanisms for cross-regional medical treatment and guide the development of a rational tiered diagnosis and treatment system. It should establish a fast-track referral channel for vulnerable groups and provide supporting services at designated hospitals, such as free professional medical escorts and cross-regional transport links [33, 34], whilst simplifying the registration process for cross-regional medical treatment to enhance patient satisfaction. Since April 2023, the Beijing-Tianjin-Hebei region has implemented direct medical insurance settlement for cross-regional medical treatment without the need for registration procedures [35], thereby promoting the convenience of medical insurance settlement services. In the future, whilst strengthening institutional oversight, it will be necessary to gradually expand the scope of service coverage to lower the barriers to healthcare access for vulnerable groups [36]. Establishing a DRG/DIP-based payment leverage system and setting reasonable regional disease-specific weighting values will enable refined management of medical insurance for cross-regional healthcare [37]. Improving the multi-tiered medical security system and exploring cross-regional coordination mechanisms for critical illness insurance will provide specialised protection for patients facing financial hardship, safeguard patients' essential cross-regional healthcare needs, and promote regional healthcare equity, whilst also addressing risks to the sustainability of medical insurance funds [38].

Patients from Tianjin seeking medical treatment in Hebei are primarily driven by geographical proximity and transport links, with most opting for general hospitals in neighbouring cities. In contrast, those travelling to Beijing are mainly driven by the quality of care, with patients tending to choose leading general hospitals or high-end private hospitals. As the capital, Beijing possesses virtually the finest medical resources across all specialities, serving as a safety net for the treatment of complex and intractable conditions nationwide. Compared with Beijing, Tianjin lags behind in terms of building nationally recognised brands for general hospitals and developing high-end private healthcare resources. In the future, support could be concentrated on leading general hospitals such as Tianjin Medical University General Hospital to enhance multidisciplinary collaborative diagnosis and treatment capabilities for complex and critical conditions, as well as scientific research and innovation, thereby narrowing the gap with Beijing's top-tier Grade-A tertiary hospitals. When high-calibre private hospitals compete in the healthcare market, they can generate positive competitive effects on the healthcare services market in terms of both cost and quality [39]. Tianjin could moderately introduce private medical institutions with clear positioning and high-quality services to form a differentiated and complementary relationship with public hospitals, thereby meeting patients' diverse healthcare needs and structurally enhancing Tianjin's overall healthcare service capacity and regional outreach.

Limitations:

This study involves a vast volume of data, covering the Beijing-Tianjin-Hebei region and employing multiple analytical dimensions, thereby providing a relatively comprehensive empirical foundation for research into the factors influencing Cross-regional healthcare-seeking behaviour among patients in Tianjin. However, the following limitations exist: the determination of Cross-regional medical treatment is

based on current residential address, which may include non-voluntary medical behaviours such as relocation for work, but given the high frequency of address updates, the impact should be relatively limited. As the researchers focused on the public policy level, variables such as patients' baseline health status were not included in the data; subsequent studies may supplement this based on further research. Furthermore, propensity score matching cannot entirely eliminate unobserved confounding factors, and causal inference remains limited. Due to restrictions imposed by the Hebei Province platform, surgery-related variables for patients from Tianjin travelling to Hebei are missing, which also imposes certain constraints on the comprehensiveness of the analysis. In future, a combination of quantitative and qualitative methods could be employed to broaden data sources and enhance the rigour of causal inference.

Conclusion

This study indicates that patients' demographic characteristics and healthcare utilisation patterns jointly influence the choice of Cross-regional medical treatment among patients in Tianjin. In future, Tianjin should optimise the geographical distribution of healthcare resources, strengthen leading specialist departments, address weaknesses in other disciplines, guide the establishment of a rational tiered healthcare system, and improve healthcare coverage for vulnerable groups seeking treatment elsewhere. This will gradually enhance the quality and outreach capacity of comprehensive regional healthcare services, thereby contributing to the d eeper integration of healthcare development across the Beijing-Tianjin-Hebei region.

Declarations

Ethics approval and consent to participate

This study used de-identified administrative healthcare data derived from the front pages of medical records held by the health commission. No directly identifiable personal information was involved, and no individual-level data were transferred outside the administrative data environment. All analyses were performed locally on secure bastion hosts within the administrative department, and only aggregated results were exported. The requirement for informed consent was therefore waived by the Ethics Committee. This study was approved by the Tsinghua University Medical Ethics Committee (IRB number: THU-01-2026-0064) and was performed in accordance with the relevant guidelines and regulations, including the Declaration of Helsinki.

Consent for publication

All authors read and approved the final manuscript.

Competing Interests

The authors declare no conflict of interests.

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Author Contribution

Yanjun Chen: Visualization, Writing -- original draft; Yuyou Cheng: Formal analysis, Visualization, Writing -- original draft; Ruilin Zheng: Investigation, Writing -- review & editing; Zhaixing Gao: Data curation; Tianqi Wang: Data curation; Jinting Liu: Data curation; Feng Lu: Methodology, Resources; Cheng Chang: Resources, Data curation; Keqin Rao: Conceptualization, Supervision, Resources, Writing -- review & editing; You Wu: Conceptualization, Resources, Supervision, Methodology, Writing -- review & editing.Yuyou Cheng, Jinting Liu, Zhaixing Gao, and Tianqi Wang accessed and verified the underlying data. Feng Lu, Cheng Chang, Keqin Rao, and You Wu confirmed responsibility for submission.

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Data Availability

This study analyzed administrative medical data, which are stored locally at the municipal data centers. Due to privacy protection and administrative restrictions, only aggregated, non-identifiable results were exported and are available from the corresponding author on reasonable request, subject to approval by the data custodians.

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Figures

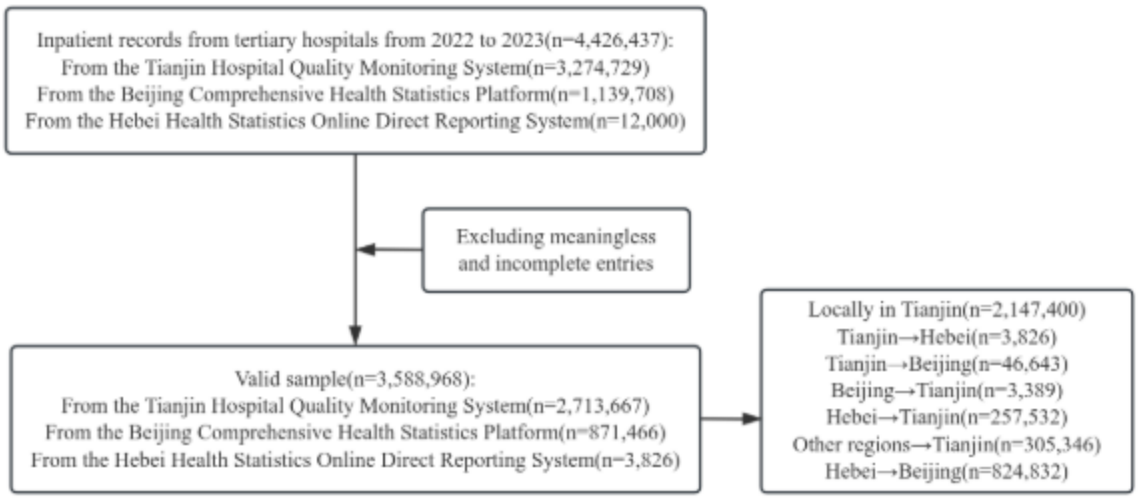


Figure 1

Data cleaning process

Notes: There were a total of 4,426,437 inpatient records from tertiary hospitals; after data cleaning, 3,588,968 valid records were ultimately included in the sample.

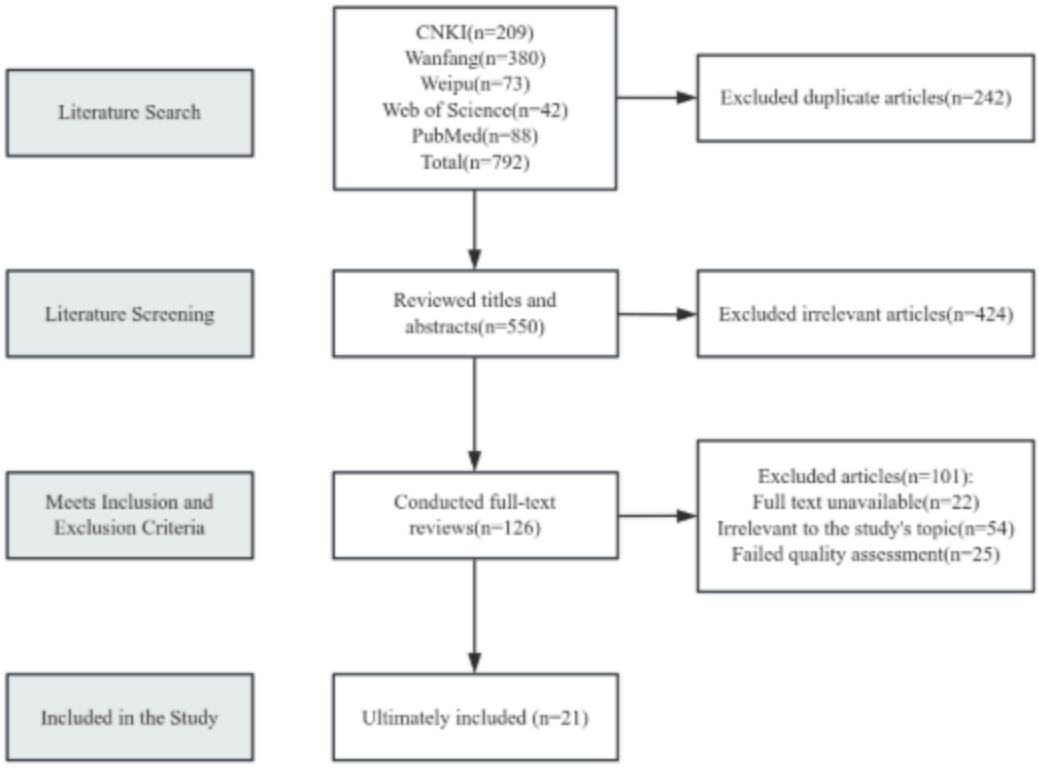


Figure 2

Literature search and screening process

Notes: Using Boolean search queries, 792 relevant articles were retrieved from six databases; after deduplication and review by two researchers, 21 articles were ultimately included.

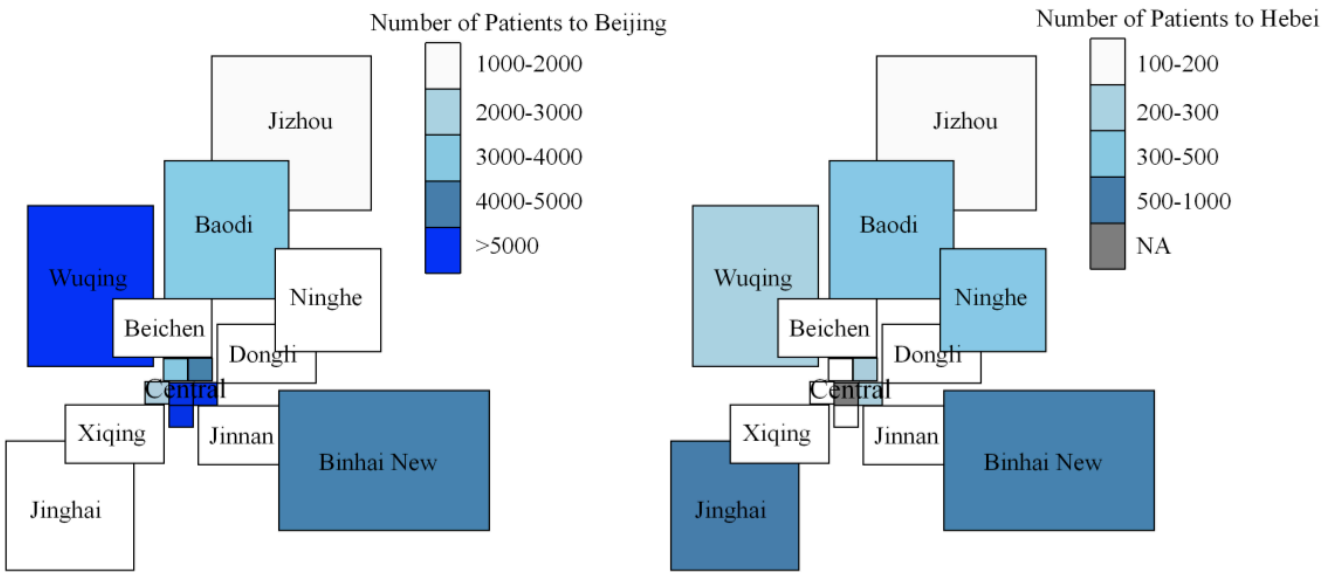


Figure 3

Map of Tianjin showing the origins of patients from various districts travelling to Beijing and Hebei for medical treatment between 2022 and 2023

Notes: The map is drawn to scale based on the actual geographical area and shows the names of each district. The central area includes Hongqiao District, Hebei District, Hedong District, Hexi District, Heping District, and Nankai District. The shades of color indicating the number of patients from that district travelling to Beijing and Hebei for medical treatment.