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Spatial Distribution Characteristics and Influencing Factors of Museums in Jining, China

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Abstract: In order to provide some reference suggestions for promoting the high-quality development of museums in prefecture-level cities and enhancing the regional cultural competitiveness based on an in-depth understanding of the evolutionary characteristics and the influence mechanism of spatial differentiation during the development of museums, 54 museums in Jining (China) were taken as the research object. The study analysed the spatial distribution characteristics of museums in each county and district of Jining and the main influencing factors were explored. The results showed that: (1) museums in Jining tend to be cohesively distributed, mainly concentrated in the central to the northern part of Jining, followed by the north-western part,

with a minor distribution in the eastern and southern parts, and the distribution of museums was uneven within Jining; (2) in terms of spatial distribution, museums in Jining have formed a major aggregation area of Qufu-Yanzhou-Rencheng, as well as a sub-aggregation area, centred on Liangshan, and Weishan, Yutai, and other places in southern Jining, although there were museums distributed, compared to the overall distribution, they were fewer in number, smaller in scope, and less evident in aggregation. (3) In terms of influencing factors, the distribution pattern of museums in Jining was related to resource endowment, highway accessibility, and water distribution, i.e., the distribution of museums was more frequent in areas with more natural and historical resources, a developed highway network, and areas near rivers or lakes. The socio-economic situation, the degree of tourism development, and the degree of population density also affected the layout of museums to a certain extent.

Keywords: Spatial distribution, Influencing factors, development of museums, Jining

Introduction

As a temple of human civilisation inheritance and emotion dissemination, museums preserve and display the witnesses of human beings and the human environment and are an essential window for people to understand the local culture, customs, and history, while also functioning as vital platforms for cultural promotion and historical education (Hu et al., 2021; Xu et al., 2018). As an important carrier of urban culture, museums contribute to improving urban public cultural service facilities and creating an excellent urban tourism environment. Under the background of integration of culture and tourism, the study of the spatial distribution characteristics of museums and their influencing factors is of great significance for the development of regional museums, the construction of excellent tourist cities and the development of cultural tourism (Li & Peng, 2020; Liu et al., 2020).

Research Problem

There is an imbalance and insufficiency in the development of museums in different parts of China, necessitating ongoing efforts to advance the high-quality development of China's museum industry in the future. However, existing studies rarely involve prefecture-level cities in China, which have abundant historical and cultural resources. And the discussion on the formation mechanism of the spatial distribution heterogeneity of museums is mainly qualitative analysis, as well as the application of mathematical methods with high accuracy is relatively rare.

Research Focus

Jining is one of the prefecture-level cities in Shandong Province, China, with two districts and seven counties under its jurisdiction and two county-level cities in its stead. Jining has a long history and culture and is one of the important birthplaces of the Dongyi culture, Huaxia civilisation, Confucian culture, Shuihu culture, and Canal culture. Humanity's ancestors, the Yellow Emperor, Confucius, and Mencius, were all born there. This study utilised Jining as a case study to investigate the spatial distribution characteristics and influencing factors of museums across various dimensions. It aims to offer insights for future research on the scientific advancement of museums and the enhancement of cultural competitiveness.

Research Aim and Questions

This study aimed to analyse the evolutionary characteristics of the spatial pattern and the potential factors influencing the spatial distribution of museums in the counties and districts of Jining. It sought to offer reference suggestions for promoting the high-quality development of museums in the prefecture-level city and enhancing regional cultural competitiveness. This was achieved through an in-depth understanding of the evolutionary characteristics and the mechanisms influencing spatial differentiation during the development of museums.

Literature Review

Despite the relatively late start of museum research in China, the achievements are considerable, which are mainly reflected in the following aspects. From the perspective of research, it mainly focused on architecture, museology, tourism, ecology, informatics, and leisure, while there were relatively few literatures from the perspective of geography (Li & Peng, 2020). In terms of research content, the museum was considered as the main body, mainly studying the architectural design of the museum (Dong et al., 2024; Xiang, 2019), exhibition (Ruan, 2009; Yang, 2023), security management (Ning, 2023; Yang, 2014) and funding sources (Li, 2023b; Yu, 2023). Other studies focus on the relationship between museums and tourism (Chen et al., 2012), including the evolution of museum functions, the demand motivation and behaviour of museum tourists, the development of museum tourism resources and cultural and creative products (Zou & Liu, 2024) and the development model of museums (Guo et al., 2023). In terms of research areas, the research mainly focuses on the national scale and economically developed cities such as Beijing, Xi'an and Shanghai (Liu, 2018; Liu & Chen, 2011; Ma et al., 2017; Yang and Zhang, 2009; Zhou, 2017) and provincial-scale region (Jiao et al., 2022; Li & Peng, 2020; Lu et al., 2024; Mou et al., 2020), while research on the prefecture-level cities is relatively rare. In terms of research methods, quantitative methods and means are gradually used to analyse the spatial and temporal distribution characteristics and influencing factors of museums (He et al., 2024; Jiao et al., 2022; Li & Pang, 2020; Liu & Chen, 2011).

As the hallmark of a city, museums represent the cultural history of a country and a nation, and show the development and economic trend of the whole human society. China's vast territory, abundant resources, different geographical environments, and colourful history and culture have created the regional characteristics of a hundred blooming flowers. In the context of the transformation of the major contradictions in society, people have put forward higher requirements for material and cultural life, and the development of museums can meet people's growing spiritual and cultural needs and have a substantial value in science and technology, history, culture, art, and tourism (He et al., 2024). Shandong Province in China is rich in cultural resources and has a very famous cultural heritage of China (Jiang et al., 2022; Li, 2023a; Meng et al., 2022). Vigorously protecting and carrying forward the Chinese culture and cultural heritage, promoting cultural protection and display at a high level, and telling the Chinese story in the new era are the current development priorities of Shandong Province. In order to better integrate and spread regional cultural resources and manage museums with local characteristics according to local conditions, various plans need to be promoted and improved under the policy guidance of the state and the government.

However, at present, the study of the formation mechanism of the spatial distribution heterogeneity of museums is mainly qualitative analysis, and applying mathematical methods with high accuracy is relatively rare. Moreover, the existing studies rarely involve prefecture-level cities in China, which have abundant historical and cultural resources. Therefore, it was strategically significant to study museums' distribution characteristics and influencing factors in prefecture-level cities in Shandong Province, China. This study aimed to use Jining City as a case study to investigate

the development status and spatial distribution characteristics of museums in the area. It also sought to examine the factors influencing these patterns, offering recommendations for museum establishment and management. Additionally, it aimed to contribute to the enrichment of museology and geography theories.

Research Methodology

General Background

This study focused on museums in Jining as the research subject, employing methods such as the Average Nearest Neighbor Index, Imbalance Index, Geographical Concentration Index, Kernel Density, and others to analyze their spatial patterns. This study also drew on relevant research results while combining the degree of resource endowment, economic development level, water system and transport network, tourism development level and population density to analyse the possible reasons affecting the spatial distribution of museums in Jining counties and districts.

Participants / Sample

The primary data of the study included (1) the Museum List of 2021 published on the website of the State Administration of Cultural Heritage of China, in which there were 54 museums belonging to Jining; (2) The geographic coordinates of the museums in Linyi obtained by using Baidu map to pick up the coordinate system, and then WGS84 coordinate system with QGIS 3.34 (Fig. 1); (3) Population and GDP of each county and district of Jining were obtained from the Statistical Yearbook of Jining and the Statistical Yearbook of Shandong Province of 2021; (4). Data of tourist attractions with grade 3A and above of each county and district of Jining were taken from the website of Jining government; (5) The geographic information of primary administrative divisions was from the website of China Temporal sequence Administrative Map; (6) The data of roads, rivers, lakes were from the website of OpenStreetMap.

Instrument and Procedures

Museums can be abstracted as point-like elements with three types of spatial distribution: random, uniform and cohesive, which are usually identified in research using the Average Nearest Neighbor Index (R). The Average Nearest neighbor formula (Eq. 1 and 2) is (Hu et al., 2021; Jiao et al., 2022):

$$R = \bar{r}_i / r_E \quad (1)$$

$$r_E = \frac{1}{2\sqrt{m/A}} = \frac{1}{2\sqrt{D}} \quad (2)$$

Where: $\bar{r}_i$ represents the mean distance between each point and its nearest neighbour; r_E is the theoretical nearest neighbor distance when point elements are randomly distributed; m represents the number of point elements; A represents the study area; D represents the number of point elements per unit area. When $R = 1$, the point element is considered randomly distributed; when $R > 1$, the point element is considered dispersed; when $R < 1$, the point element is considered clustered.

The imbalance index (S) can reflect the degree of balanced distribution of museums in Jining, and is calculated as follows (Eq. 3) (Jiao et al., 2022; Ma et al., 2017; Yang and Zhang, 2009):

$$S = \frac{\sum_{i=1}^n Y_i - 50(n+1)}{100n - 50(n+1)} \quad (3)$$

Where: n denotes the number of counties and districts in Linyi; Y_i denotes the cumulative percentage of the number of museums in each county and district as a proportion of the total number of museums in Linyi, ranked from largest to smallest after the i th position. S takes values from 0 to 1: when $S = 0$, the transmission of museums is evenly distributed in the counties and districts; when $S=1$, the museums are all concentrated in one county and district.

The Geographical Concentration Index (G) served to assess the concentration of the distribution of the object under study and is utilised here to investigate the concentration of museum distribution (Eq. 4) (Liu & Chen, 2011; Mou et al., 2020; Zhou, 2017):

$$G = 100 \sqrt{\sum_{i=1}^n \left(\frac{X_i}{T} \right)^2} \quad (4)$$

Where: X_i represents the number of museums owned by the i th county and district in Linyi; T is the total number of museums in each county and district in Linyi; n represents the number of counties and districts in Linyi; the larger the value of G , the higher the degree of concentration, assuming that museums are evenly distributed when $G = G_0$; if $G > G_0$, it means that museums are concentrated, and conversely, more dispersed.

Kernel density can calculate the density of point elements around each output grid, which can intuitively reflect the degree of concentration and discrete traditional villages; the formula (Eq. 5) is (Liu, 2018; Wu et al., 2023; Zhan et al., 2021):

$$f(x) = \frac{1}{nh} \sum_{i=1}^n k \left(\frac{x - x_i}{h} \right) \quad (5)$$

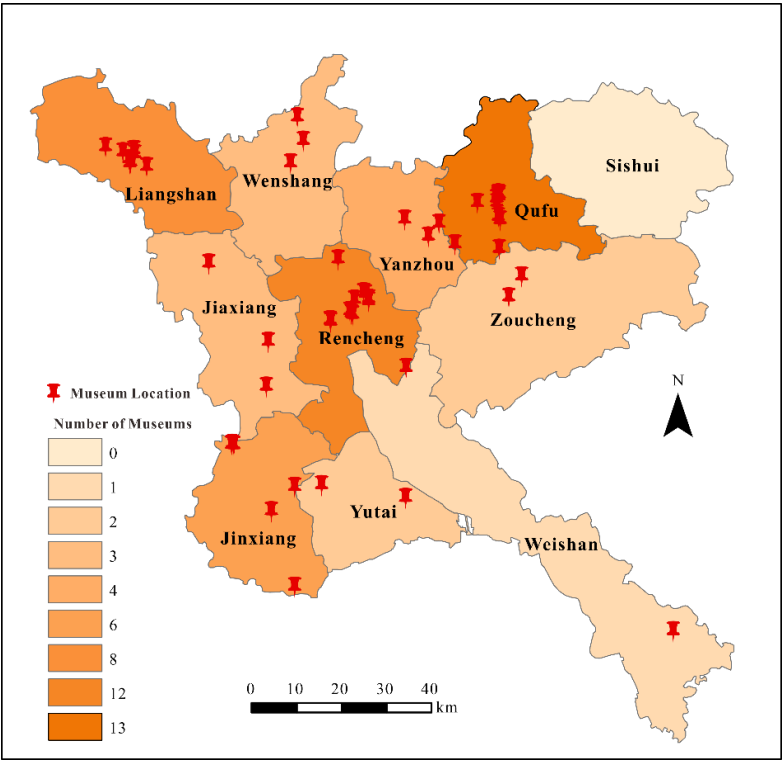
Where: $k()$ is the kernel density function; h is the bandwidth; n is the number of points in the threshold range; $(x-x_i)$ denotes the distance from the valuation point x to the event x_i .

Data Analysis

Spatial Distribution. From the municipal level, museums can be regarded as point-like elements, and coordinate points represent their geographic locations. The collected and organised data of all museums in Jining are imported into ArcGIS 10.8 software. The quantity statistics and visualisation are carried out by counties and districts, resulting in the distribution map of the number of museums in each county and district in Jining (Fig. 1). The red data points represent the precise locations of the museums, while the varying shades of the underlying colour within each county denote the number of museums present in that county. At present, the number of museums in each county and district in Jining reaches 54, of which 13 are in Qufu, 12 in Rencheng, eight in Liangshan, six in Jinxiang, four in Yanzhou, three in Jiaxiang and Wenshang, two in Yutai and Zoucheng, one in Weishan and zero in Sishui. Overall, the number of museums in Jining's counties and districts considerably varies, and the construction situation is uneven.

Figure 1

Distribution of museums in Jining



Source: Author's own development.

Table 1

Average Nearest Neighbors Summary of Museums in Jining

Observed Mean Distance/m	Expected Mean Distance/m	Nearest Neighbor Ratio	z-score	p-value
5059.0470	7244.3402	0.698345	-4.240711	0.000022

Source: Author's own development.

Types of Spatial Distribution. The point elements usually have three spatial distribution types: random, uniform, and clustered. We imported the coordinates of 54 museums in each county of Jining into ArcGIS 10.8 software platform, through which the average nearest neighbor tool was operated (Eq. 1), and the average nearest neighbor operation result (Table 1) was obtained, in which the z-value was -4.240711 and p -value was 0.000022, indicating that the possibility of this clustering pattern being randomly generated is minimal; the R -value was 0.698345, which means that $R < 1$, so it can be determined that the spatial distribution type of museums in each county of Jining belongs to the clustered type of distribution.

Degree of Equilibrium in Spatial Distribution. The Imbalance Index can assess the level of equilibrium in the distribution of point elements across different regions. Using EXCEL to calculate the imbalance index $S = 0.503704$ according to the formula (Eq. 3), indicating that the distribution of museums in Jining districts and counties is unbalanced (Table 2). Based on the above statistics, the Lorenz curve of the number of museums in each district and county of Jining and the uniform

distribution line is drawn (Fig. 2). The Lorenz curve is farther away from the uniform distribution line, and the curve protrudes with a more significant curvature, which indicates that the distribution of museums is unbalanced in each region. The number of museums in the three counties and districts of Qufu, Rengcheng and Liangshan together accounted for 61.1%, while the number of museums in Wenshang, Zoucheng and Yutai was less, and Sishui did not even build one museum. As seen in Table 3, Jining City has 54 museums, and according to the average calculation of 11 counties and districts, each county and district should have no less than five museums. Moreover, seven counties and districts have failed to meet this standard, accounting for 63.6% of all counties and districts.

Table 2

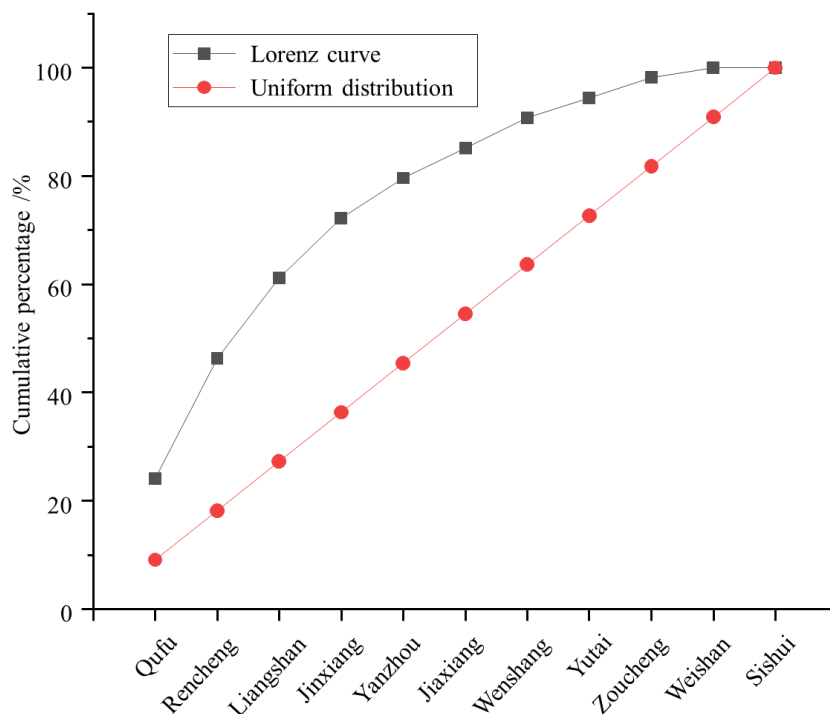
Table of imbalance index of Museums in Jining

No	County or district	Total number of museums	Y _i /%	Y _i cumulative percentage/%	S
1	Qufu	13	24.074074	24.074074	0.503704
2	Rengcheng	12	22.222222	46.296296	
3	Liangshan	8	14.814815	61.111111	
4	Jinxiang	6	11.111111	72.222222	
5	Yanzhou	4	7.407407	79.629630	
6	Jiaxiang	3	5.555556	85.185185	
7	Wenshang	3	5.555556	90.740741	
8	Yutai	2	3.703704	94.444444	
9	Zoucheng	2	3.703704	98.148148	
10	Weishan	1	1.851852	100.000000	
11	Sishui	0	0.000000	100.000000	
Total		54	100.000000	851.851852	

Source: Author's own development.

Figure 2

Lorentz curve of distribution of museums in Jining

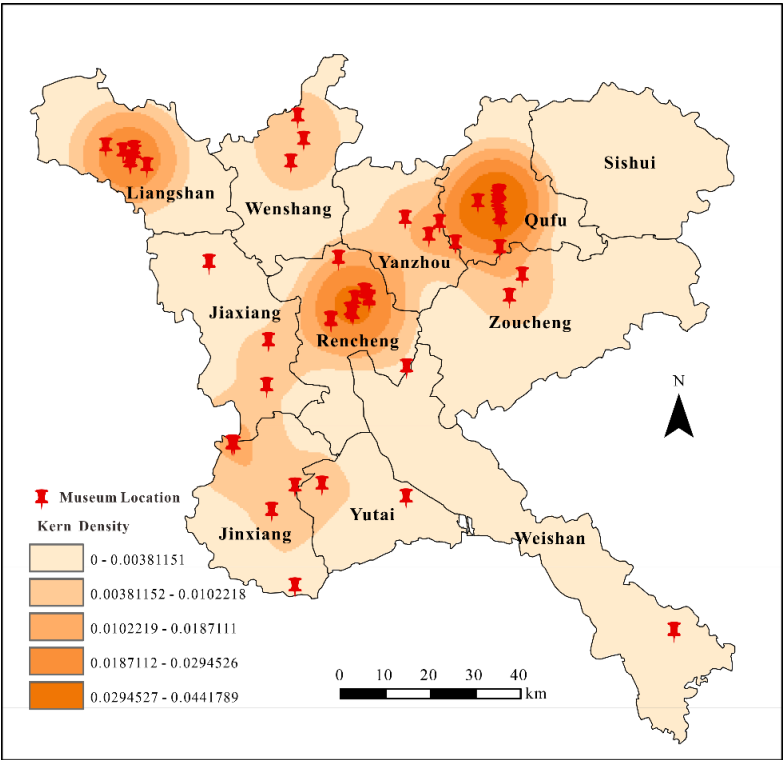


Source: Author's own development.

Analysis of spatial distribution clustered area. From the equation (4) of the geographic concentration index, $G = 39.544734$ and $G_0 = 30.151134$ (Table 3). The results show that $G > G_0$, thus indicating that the museums in the districts and counties of Jining present a concentrated distribution and a high degree of concentration. Utilising the kernel density analysis function of ArcGIS 10.8, we conducted kernel density calculations (Eq. 5) to produce a kernel density map illustrating the spatial distribution of museums across the counties and districts of Jining (Fig. 3). As can be seen from Fig. 3, museums in Jining counties and districts show evident spatial heterogeneity, with concentrated museum areas located in the central and northern parts of the city, forming the Qufu-Yanzhou-Rencheng agglomeration area with Qufu and Rencheng as the core, with a high density and a certain degree of continuity; a secondary agglomeration area is formed with Liangshan as the core; and there are fewer museums distributed in the southern and eastern parts of Jining, with Sishui, Weishan, and Yutai failing to form a large-scale gathering area. From a city-wide perspective, the number of museums shows evidential spatial differences, roughly more in the center and north, followed by the northwest, and least in the east and south. Especially in Sishui, located in the east of Jining, there is not a single museum in the whole county; although there are museums in Weishan, Yutai, Zoucheng and other places in the south of Jining, they are few, small in scope, and inconspicuous in grouping compared to the overall distribution.

Figure 3

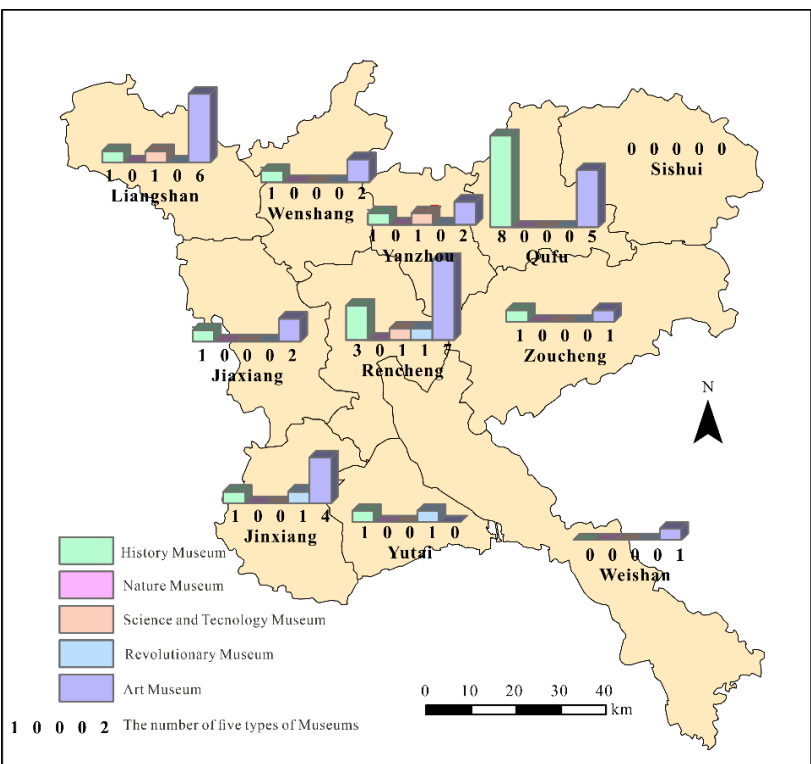
Kernel density map of museums in Jining



Source: Authors' own development.

Figure 4

Distribution of Five Types of Museums in Jining



Source: Authors' own development.

Table 3

Table of geographical concentration index of Museums in Jining

No	County or district	Total number of museums	x_i/T	$(x_i/T)^2$	Suppose under uniform distribution			G_0	G
					The number of museums	x_i/T	$(x_i/T)^2$		
1	Qufu	13	0.2407	0.0570	4.9091	0.0909	0.0083	30.151	39.545
2	Rencheng	12	0.2222	0.0491	4.9091	0.0909	0.0083		
3	Liangshan	8	0.1481	0.0219	4.9091	0.0909	0.0083		
4	Jinxiang	6	0.1111	0.0123	4.9091	0.0909	0.0083		
5	Yanzhou	4	0.0741	0.0055	4.9091	0.0909	0.0083		
6	Jiaxiang	3	0.0556	0.0031	4.9091	0.0909	0.0083		
7	Wenshang	3	0.0556	0.0031	4.9091	0.0909	0.0083		
8	Yutai	2	0.0370	0.0014	4.9091	0.0909	0.0083		
9	Zoucheng	2	0.0370	0.0014	4.9091	0.0909	0.0083		
10	Weishan	1	0.0185	0.0003	4.9091	0.0909	0.0083		
11	Sishui	0	0.0000	0.0000	4.9091	0.0909	0.0083		
Total		54			54		0.0083		

Source: Authors' own development.

Results

Typically, the factors influencing the spatial distribution of museums predominantly include natural history and cultural significance, the level of socio-economic development, the level of scientific and educational development, the level of tourism development, urban planning, and government policy orientation. This paper drew on relevant research results while combining the spatial distribution of museums in Jining counties and districts in order to analyse the possible reasons affecting the spatial distribution of museums in Jining counties and districts.

Degree of Resource Endowment

Natural and cultural resources are the material basis for museum construction. Jining has a long history and culture and is one of the important birthplaces of the Dongyi culture, Chinese civilisation, Confucian culture, Shuihu culture, and Canal culture. The above creates conditions for the construction of historical museums, for example, the "San Kong" (the San Kong refer to Confucius Temple, Confucius Mansion and Confucius Forest, of which the Confucius Temple is the temple for Confucius, the Confucius Mansion is the place where the direct descendants of Confucius live, and the Confucius Forest is the particular graveyard for Confucius and his family) and the Beijing-Hangzhou Grand Canal are the world cultural heritages, so that the historical museums in Qufu and

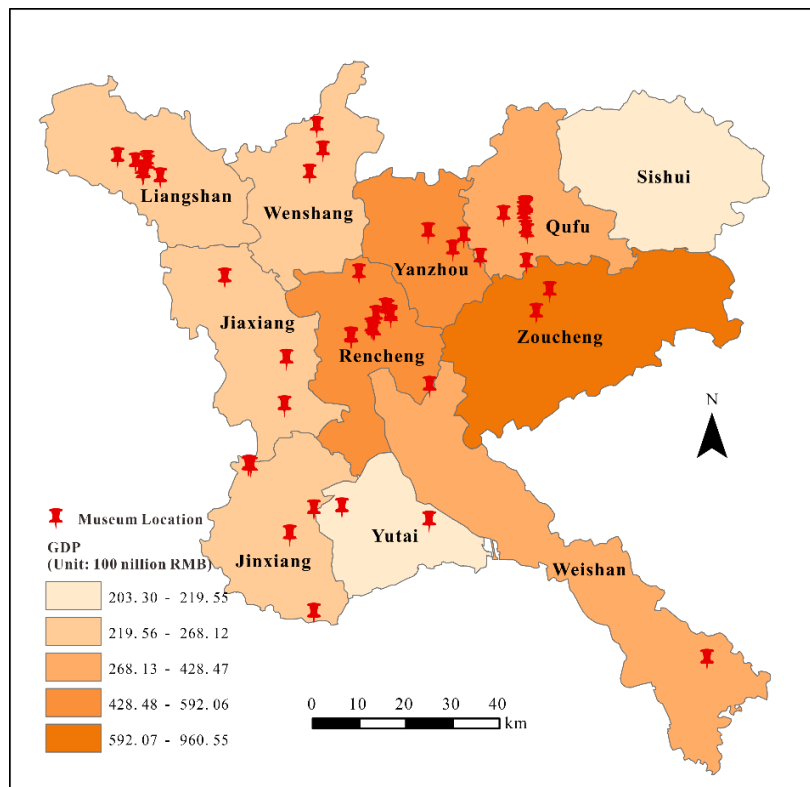
Rencheng are densely distributed. In addition, Jining is one of the important birthplaces of the Eastern barbarian culture, Huaxia civilisation, Confucian culture, Water Margin culture and Canal culture, and Qufu, Liangshan, Rencheng and Jinxiang are important areas for the inheritance and preservation of traditional culture, with better-preserved art and cultural resources. Hence, these districts and counties have a more significant number of art museums (Fig. 4).

Economic Development Level

Museums serve as crucial venues for urban residents' leisure, entertainment, and educational pursuits. Given that residents' income levels directly influence their consumption of museums, they inevitably play a significant role in shaping the spatial distribution of these institutions. The GDP of Jining counties and districts in 2021 is overlaid with the distribution of museums, and the results are shown in Figure 5. The GDP level of Jining counties and districts is not balanced and has apparent differences. Overall, counties and districts with a high density of museums generally have relatively high GDP levels; however, counties and districts with high GDP levels do not necessarily have a high density of museums. Counties and districts such as Qufu, Rencheng, and Yanzhou have relatively high levels of economic development, and the number of museums in these areas is also relatively high. However, Zoucheng and Weishan are the most special among the counties and districts in Jining. For example, Zoucheng has the highest GDP among the counties and districts, but the number of museums is ranked almost at the bottom of the list; Weishan County's GDP is in the middle of Jining, however, the number of museums ranks second to last on the list, likely due to the fact that much of the Weishan area comprises an exceptional geographical feature of water bodies.

Figure 5

Superposition Analysis of GDP and Museum Distribution in Jining



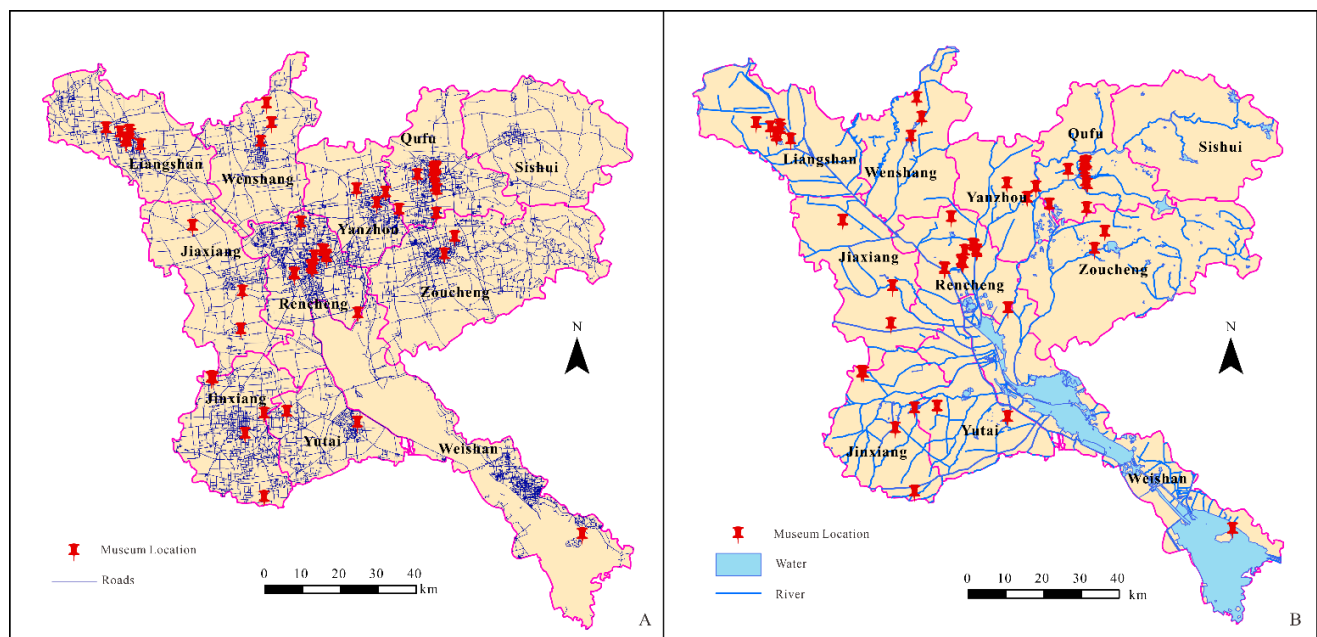
Source: Authors' own development.

Water System and Transport Network

The distribution of major highways, rivers, and waters in Jining districts and counties is superimposed on the distribution of museums, and the results are shown in Figure 6. As shown in the figure, museums in all counties and districts of Jining are basically constructed in areas with well-developed highway networks, and present the characteristics of being close to rivers or lakes and other waters, with only a few museums located further away from the highways and waters. As important public cultural facilities, local governments (state-owned museums) or museum owners (non-state-owned museums) generally pay more attention to the location of museums in order to make them easily accessible to citizens and tourists. In addition, the Beijing-Hangzhou Grand Canal, which passes through Jining's jurisdiction, has spawned hundreds of years of prosperity in Jining and once pushed the commercial civilisation of Jining to its peak. Currently, Jining's inland waterways have a navigable mileage of about 1,150 kilometers, accounting for about 70% of the mileage of inland waterways in Shandong Province, China. Furthermore, in recent years, to bolster tourism, several new museums have emerged, strategically located near rivers and lakes, as these places have beautiful natural landscapes and convenient land and water transport, which make them more attractive to tourists.

Figure 6

Superposition Analysis of Roads, Rivers, and Museum Distribution in Jining



Source: Authors' own development.

Tourism Development Level

Tourist destinations in Jining City are relatively clustered, with two 5A-level scenic spots, 18 4A-level scenic spots, and 54 3A-level scenic spots in the Qufu San Kong Tourist Area and Weishan Lake Tourist Area. From the distribution of 3A-level and above scenic spots, the counties and districts of Jining have a total of 74 3A-level and above scenic spots (Table 4), of which Zoucheng, Jiaxiang, Qufu, Sishui ranked in the top four, respectively, with 18, 11, 9 and 8. The number of 3A-level and above scenic spots in the above four counties and districts totals 46, accounting for 62.2% of the total number of museums in Jining. 3A-level and above scenic spots have excellent tourist attractions and good customer sources, which is the center of gravity of tourism development, and can provide a market guarantee for museums to attract flow and increase income, and have a particularly positive

effect on the construction of museums. However, Jining seems to be in a unique situation, and only Qufu meets the above law. Sishui, Zoucheng, and Jiaxiang rank at the top of the city in terms of the number of scenic spots of grade 3A-level and above, but the number of museums is only 19, accounting for only 35.2% of the total number of museums in Jining.

Table 4

Distribution of Scenic Spots and Ownership of Museums in Jining

County or district	The number of Scenic Spots			The number of museums		
	5A-level	4A-level	3A-level	State-owned	Non-state-owned	Total
Qufu	1	4	6	7	5	13
Rencheng	0	1	3	2	10	12
Liangshan	0	2	2	1	7	8
Jinxiang	0	1	5	2	4	6
Yanzhou	0	0	2	1	3	4
Jiaxiang	0	1	8	1	2	3
Wenshang	0	2	5	2	1	3
Yutai	0	0	2	2	0	2
Zoucheng	0	4	14	1	1	2
Weishan	1	1	1	0	1	1
Sishui	0	2	6	0	0	0

Source: Authors' own development.

Population Density

The population density of Jining counties and districts is superimposed on the distribution of museums, and the results are shown in Figure 7. Overall, except for Sishui, the population density of Jining counties and districts shows a certain regularity, with Rencheng as the central urban area having the highest population density and the population density of other counties and districts gradually decreasing from the northwest to the southeast. The overall spatial distribution of museums exhibits a positive correlation with population density. Areas with higher population concentrations, indicative of greater urbanization and superior infrastructure, tend to host more museums. However, there are a few counties that do not conform to this pattern, for example, Yanzhou and Wenshang, which have higher population densities but fewer museums; and Sishui, which has the lowest population density but zero museums, which conforms to the above pattern, but is still rare for a county to have no museums at all.

Discussion

Overall, the distribution of museums in Jining's counties and districts is of an aggregated type, with an uneven distribution of museums across the city, with most museums located in the central and northern parts of Jining, with Qufu, Rencheng and Liangshan together accounting for 61.1% of the total number of museums. At the county level, museums are clustered and highly concentrated,

with Qufu and Rencheng forming the central cluster of Qufu-Yanzhou-Rencheng and the secondary cluster of Liangshan. The aggregated distribution of museums in Jining's counties aligns with the findings of studies on the spatial distribution characteristics of museums in other regions of China, such as the spatial distribution characteristics of museums in Anhui Province (Li & Peng, 2020), the spatial distribution characteristics of museums in the Wuling Mountain Area (Liu et al., 2020), the spatial distribution characteristics of museums in Yunnan Province (Jiao et al., 2022), and the spatial distribution characteristics of museums in the Grand Canal Cultural Belt (Wu et al., 2023).

Through the degree of resource endowment, socio-economic conditions, traffic accessibility, tourism development, population density, and other factors in Jining counties and districts, the analysis of the spatial distribution of museums reveals that it is influenced by multiple factors acting in concert. Some scholars have also reached the same conclusion in their studies on the factors affecting the distribution of museums in other regions of China (He et al., 2024). The resource endowment greatly influences museums' distribution, but the distribution pattern is even more a witness to the local people's creation of humanistic landscapes based on nature. In this study, the influence of natural historical conditions such as the resource endowment and water distribution and the influence of road traffic, socio-economic and demographic factors on museums are further analysed based on resource conditions.

The research object is based on the 2021 Chinese museum directory, which is rich in data, real-time, and authoritative. The analysis found that the resource endowment, socio-economic conditions, road and waterway accessibility, tourism development level, population density and other elements impacted museums' distribution. Meanwhile, the progress of Geographic Information System technology also provided technical support for data analysis. This paper studied the spatial distribution of museums in Jining City and its influencing factors, and had certain guiding significance for the rational layout of museums in Jining City. However, due to the availability of data and the limitation of the length of the article, there were still some shortcomings in the study. (1) When studying the spatial distribution characteristics of the museums in Jining, this study did not consider the quality grade, number of activities, number of visitors and so on. (2) The degree of resource endowment, economic development level, water system and transport network, tourism development level and population density and other influencing factors have been considered, but mainly based on semi-qualitative analysis. (3) In addition to the question, what is the difference between the evolution of museum pattern in Jining and other prefecture-level cities in Shandong Province? This issue needs to be further discussed in the future.

Conclusions and Implications

In terms of spatial distribution, the whole of Jining's museums exhibit a clustered spatial arrangement, contributing to the primary cluster area encompassing the main aggregation area that forms Qufu-Yanzhou-Rencheng and a secondary aggregation area centred on Liangshan. The number of museums shows an ample spatial difference, with more in the center and the north, followed by the northwest, and the least in the east and the south. Sishui, located in the eastern part of Jining, does not have a single museum in the whole county; although there are museums in Weishan, Yutai and Zoucheng in the southern part of Jining, they are sparse, limited in scope, and relatively insignificant in aggregation compared to the overall distribution.

In terms of influencing factors, the distribution pattern of museums in Jining City is related to resource endowment, road accessibility and water distribution, i.e., the distribution of museums is more frequent in areas with more natural and historical resources, developed road networks and near rivers or lakes. The socio-economic situation, the degree of tourism development, as well as

the population density also affect the museum's layout to a certain extent. A good economic development situation and a concentrated population are more likely to improve the infrastructure by forming museum resources with local characteristics.

Suggestions for Future Research

This study holds significant reference value for enhancing regional cultural competitiveness, promoting the development of cultural and museum undertakings, and improving the level of public cultural services. However, limited by the data availability, it does not discuss the influencing factors of museum development in multiple periods. In addition, whether the influencing factors of the spatial evolution pattern of different types of museums at different scales are different will be the direction of future research. Based on the results of this study, it should be further focused on the types and levels of museums, a classification and classification discussions should be conducted, and the spatio-temporal rules and formation reasons of museum undertakings from multiple perspectives should be deeply explored. Other effective and quantitative methods to study the distribution characteristics and influencing factors of museums should also be explored. In addition, it is also necessary to consider how the evolution of museum pattern in Jiangxi Province differs from that in other provinces.

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