RESEARCH

Distribution characteristics and influencing factors of Intangible Cultural Heritage in Beijing-Tianjin-Hebei

Ling Pang[*] and Lina Wu

Abstract

The Beijing-Tianjin-Hebei region, with the capital Beijing as the core, carries a profound geo-culture and gathers numerous intangible cultural heritages. Studying the spatial distribution characteristics and influencing factors of intangible cultural heritage can help to propose positive suggestions for protection and development from the perspective of sustainable development. Taking 329 national intangible cultural heritages in Beijing-Tianjin—Hebei as the research objects, and using ArcGIS spatial analysis technology, combined with methods such as kernel density analysis, standard deviation ellipse and geographical detector, to visualize the spatial distribution of intangible cultural heritages and explore the influencing factors of their distribution. The results show that: (1) the distribution of intangible cultural heritage in Beijing-Tianjin-Hebei is not balanced, mainly concentrated in the central and southern regions, and three high-density core circles are formed in Beijing, Tianjin, and Handan-Xingtai in Hebei Province, showing large differences in spatial distribution density; (2) Traditional techniques, traditional arts, dramatic balladry, sports, music, and medicine show the characteristics of aggregated distribution. folkways, dance, and drama show the characteristics of random distribution. Folk literature shows the characteristics of uniform distribution; (3) The Cultural Development Period is an important evolutionary turning point in the spatial and temporal distribution of intangible cultural heritage in Beijing-Tianjin-Hebei, as well as an accelerating period in the development of intangible cultural heritage, and completes the transformation from decentralized distribution to localized aggregation distribution. In The Period of Regional Cultural Integration, the peak value is reached; (4) Economic development and social culture have the greatest influence on the spatial distribution of intangible cultural heritage in Beijing-Tianjin-Hebei, while the influence of physical environment is relatively small.

Keywords Beijing-Tianjin-Hebei region, Intangible cultural heritage, Spatial and temporal distribution, Influencing factors

Introduction

Intangible cultural heritage is a cultural site formed by the evolution of individual or collective historical social practices and development of human beings. It is carried in oral and expressive forms and contains many categories such as language, art, folklore, traditional skills, and other related disciplines such as history, anthropology, and geography [1]. Meanwhile, intangible cultural heritage covers characteristics such as authenticity, wholeness, and transmission [2]. However, in the context of plus urbanization, intangible cultural heritage is facing the dilemma of inheritance and development, and there are problems such as lack of awareness of protection of intangible heritage values, difficulty in inheritance and blind exploitation [3].

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With the value discovery and extinction crisis of intangible cultural heritage, UNESCO passed the "Convention on the Protection of Intangible Cultural Heritage" in 2003; in 2011, China officially implemented the Law of the People's Republic of China on Intangible Cultural Heritage, which clearly defines the attributes and categories of intangible heritage and requires strengthening the protection measures for intangible heritage; The "14th Five-Year Plan for Intangible Cultural Heritage Protection Plan" promulgated in 2021 sets out more detailed planning requirements for intangible cultural heritage protection [4]. Up to now, the list of China's national intangible cultural heritage was first announced by the Ministry of Culture and Tourism in 2006, with a total of 1557 items and 3610 sub-items in five batches. Under the promotion of the government, a large number of scholars, researchers, non-governmental and organizations have invested in the protection of intangible cultural heritage. At present, there are more studies on intangible cultural heritage, involving various disciplines such as history, geography, anthropology and tourism, mainly focusing on the following aspects. First, from the perspective of conservation and development history, we study the classification and construction characteristics of intangible cultural heritage [5, 6], situation and countermeasures [7, 8], inheritance of intangible cultural heritage [9], organization and management [10]; second, from the perspective of human history and cultural heritage value, we study the landscape genes of intangible cultural heritage [11], revitalization of rural culture [12], and economic value [13]; third, from the perspective of sustainable development, we study the development of intangible cultural heritage [14, 15], dissemination [16, 17], tourism development [18, 19], living protection [20, 21]; fourth, from a macroscopic perspective, combined with the GIS spatial analysis method, for the distribution of intangible cultural heritage, to find its objective patterns as well as influencing factors. This type of research involves multiple scales, mainly focusing on the national scale [22–24], the multi-provincial scale [25–34], the single-provincial scale [35–45], and the municipal scale [46–50]. Many factors associated with intangible cultural heritage are explored from various perspectives, including regional environment, regional development, history and humanity.

At present, there are many research results on the distribution characteristics of intangible cultural heritage, covering a wide range of areas, but the research content is mostly based on the current distribution of intangible cultural heritage, and there have few research from the perspective of temporal evolution. The number of research on intangible cultural heritage in Beijing-Tianjin-Hebei is relatively small, including regional tourism [51], historical inheritance [52, 53], single sports type characteristics [54], cultural heritage protection units [55], and cultural landscapes [56], lacking a macroscopic perspective study on the distribution of intangible cultural heritage. Therefore, based on the existing research results, this paper combines GIS spatial analysis tools to visualize the overall pattern of national intangible cultural heritage in Beijing-Tianjin-Hebei, summarize its spatial and temporal distribution characteristics and its influence mechanism, and provide a scientific basis for the development planning of intangible cultural heritage.
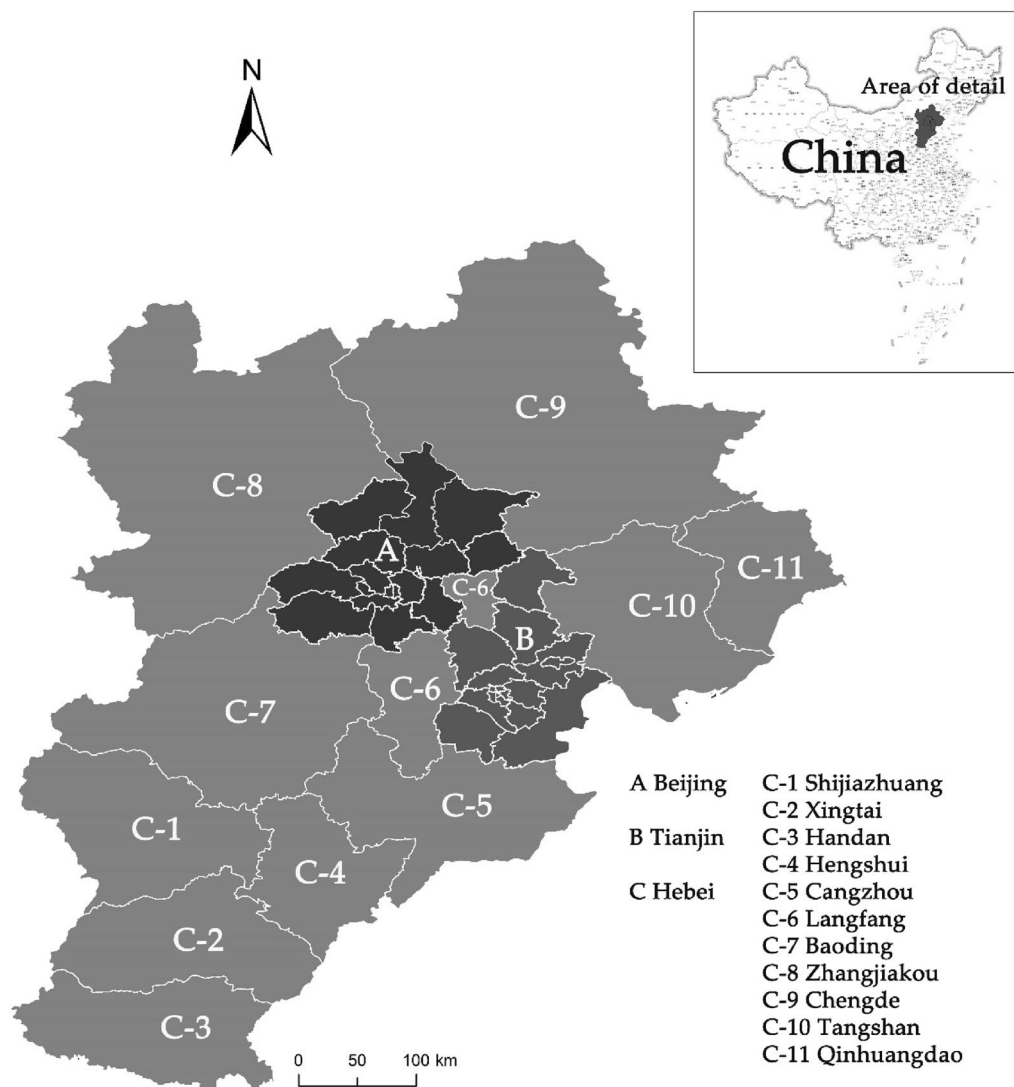
Materials and methods

Study area

The Beijing-Tianjin-Hebei region is located in the core of China's Bohai Bay, covers Beijing, Tianjin and many cities in Hebei Province, making it the largest economic circle in northern China (Fig. 1). Beijing-Tianjin-Hebei is connected to Shanxi Province in the west, Inner Mongolia and Liaoning Province to the north, Henan Province and Shandong Province to the south and is surrounded by Bohai Bay in the east. The total amount of water resources in the territory is relatively scarce, and the average per capita is low. The climate is warm temperate continental monsoon type climate. Beijing, Tianjin and Hebei Province. Due to its special historical background and geographical relationship, Beijing-Tianjin-Hebei constitutes a regional culture with a continuous line, and retains a large number of historical and cultural heritages. The cultural heritage is especially prosperous in the Yuan, Ming and Qing Dynasties, has been attached to the political functions of the capital for more than 800 years, forming a Chinese civilization with a long history and rich resources.

Data resources

The information and data on national intangible cultural heritage referenced in this article are from the China Intangible Cultural Heritage Network—Digital Museum (https://www.ihchina.cn). Since the first batch of projects was announced in 2006, there are five batches by 2021, including 59 projects in the first batch, 147 projects in the second batch, 35 projects in the third batch, 42 projects in the fourth batch, and the fifth batch 46 items, a total of 329 items. The base map is made based on the standard map downloaded from the website of the National Geographic Information Public Service Platform, and the review number is GS (2016) 1610; DEM data such as terrain elevation and other DEM data are from Geospatial Data Cloud (http://www.gscloud.cn/); Use the coordinate pickup function of Baidu Maps to determine the geographic location of the Beijing-Tianjin-Hebei intangible cultural heritage. Combined with ArcGIS10.2 and Excel,

Fig. 1 Location of the Study Area in China

the coordinate data was processed to make a spatial distribution map of Beijing-Tianjin-Hebei.

Research methods

Nearest neighbor index

Intangible cultural heritage can be spatially abstracted into point-like elements, which are usually of three types of distribution. They are uniform distribution, random distribution and aggregated distribution [57]. Calculating the nearest neighbor index allows to derive their distribution categories. The estimation formula is:

$$R = \frac{1}{2\sqrt{n/A}} = \frac{1}{2\sqrt{D}} \tag{1}$$

Equation: R denotes the nearest neighbor index; $\bar{r}_I$ denotes the actual nearest neighbor distance; $\bar{r}_E$ denotes the theoretical nearest neighbor distance. When R = 1, it indicates that the intangible cultural heritage is randomly distributed in the Beijing-Tianjin-Hebei territory; R > 1, it indicates that the intangible cultural heritage is uniformly distributed; R < 1, the intangible cultural heritage is cohesively distributed [58].

Kernel density estimation

Calculate the number of geospatial grid densities around point features to analyze the aggregation degree of regional resources [59]. The raster density quantities are positively correlated with the selected radius of point elements, and are combined to form the spatial

characteristics of kernel density to reflect the spatial distribution pattern of intangible cultural heritage in Beijing, Tianjin and Hebei. The calculation formula is:

$$f_n(x) = \frac{1}{nh_n} \sum_{j=1}^{n} k\left(\frac{x - x_j}{h_n}\right) \tag{2}$$

Equation: $f_n(x)$ is the kernel density estimate at location X; $k\left(\frac{x-x_j}{h_n}\right)$ is the kernel function; n is the number of data; and $(x - x_j)$ is the distance value from the valuation point x to the intangible cultural heritage point x_j [60].

Standard deviation ellipse
From the perspective of global space, based on the spatial characteristics of the research object, analyze the central trend, dispersion degree, directional trend and other characteristics of the spatial distribution of geographic elements, and finally derive the spatial distribution and spatial and temporal evolution process of geographic elements [61].

$$SDE_x = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \overline{X})^2}{n}} \tag{3}$$

$$SDE_x = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \overline{X})^2}{n}} \tag{4}$$

Equation: x_i and y_i represent the coordinates of Beijing-Tianjin-Hebei national intangible cultural heritage; $\{\overline{X}, \overline{Y}\}$ represent the average center of intangible cultural heritage; n represents the total number of intangible cultural heritage [62].

Geographical detector
Geographic detectors can detect the formation relationship of the spatial distribution of intangible cultural heritage and test the coupling of the spatial distribution of two variables [63]. It is a statistical tool for spatial analysis.

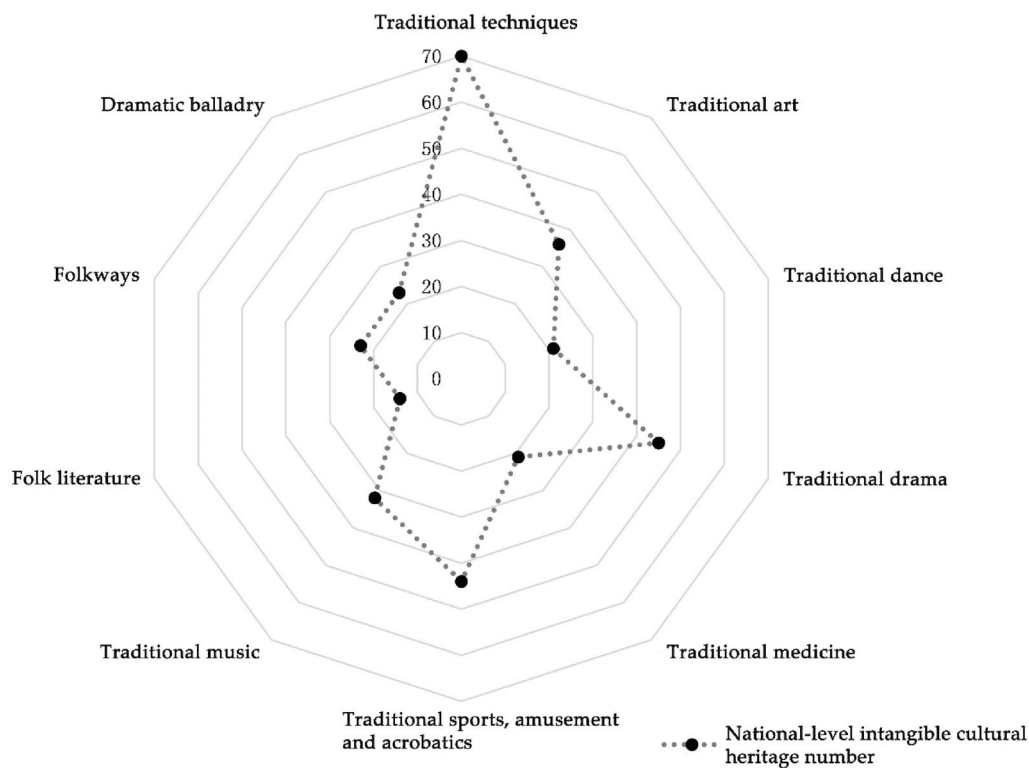$$q = \left(N\sigma^2 - \sum_{h=1}^{L} N_h \sigma_h^2\right) / N\sigma^2 \tag{5}$$

Equation: N 和 σ^2 are the sample size and variance of the intangible cultural heritage; N_h 和 σ_h^2 are the sample size and variance of the h-th type of influencing factors; L is the classification number of the $h-th$ type of influential factors. The larger the q value, the greater the influence of the factor on the spatial distribution of intangible cultural heritage [64].

Results and analysis
Structural distribution characteristics
According to the ten categories in the official list, the radar chart of intangible cultural heritage statistics of Beijing-Tianjin-Hebei was obtained by using the data function of Excel table (Fig. 2). As shown in the figure, the number of intangible cultural heritage with traditional techniques in the Beijing-Tianjin-Hebei region is the largest, accounting for 21.28; Followed by traditional drama and traditional sports, amusement and acrobatics accounted for 13.68% and 13.37%. The number of traditional art and traditional music is the most balanced, accounting for 10.94% and 9.73%; the folkways, dramatic balladry, traditional dance and traditional medicine is lower, accounting for 6.99%, 6.99%, 6.38% and 6.38%. The proportion of folk literature is the lowest, only 4.26%. The results show that there are a large number of national intangible cultural heritage in Beijing-Tianjin-Hebei, and the number of each type of projects shows great differences. For the rare intangible cultural heritage such as folk literature, it is necessary to improve the protection awareness and inheritance methods in order to achieve sustainable development.

In order to understand the types and quantities of intangible cultural heritage covered in each region of Beijing-Tianjin-Hebei, make a table of intangible cultural heritage type-geography quantity distribution (Table 1). From the perspective of distribution, Hebei Province has the largest number of intangible cultural heritage, with a total of 162, accounting for 49.24%; followed by Beijing, with a total of 120, accounting for 36.47%; Tianjin is the least, with a total of 47, accounting for 14.29%. In terms of distribution density, the overall average density is 15.15 items/10000 km^2. Beijing is the densest, with a density of 73.13items/10000 km^2, which is much higher than the average; followed by Tianjin with a density of 39.26 items/10000 km^2; Hebei Province with the lowest density, only 8.5815.15 items/10000 km^2, which is far below the average. From the perspective of distribution type, the number of techniques in Beijing is the most significant, accounting for 36.47%, followed by art and sports, accounting for 15% and 10%, while the number of drama and music is the least, accounting for only 4.17% and 3.33%; Tianjin has the largest number of techniques, medicine and sports, all accounting for 17%, and the number of folkways, dance and folk literature is the least, accounting for 5%, 2.13%, and 2.13%; Hebei has the largest number of dramas, accounting for 22.22%, the number of folk literature and medicine is the least, accounting for 3% and 2%.

Fig. 2 Structure diagram of intangible cultural heritage types in Beijing-Tianjin-Hebei Region

Regional distribution characteristics
Overall regional distribution characteristics
Using the ArcGIS kernel density analysis tool, the kernel density analysis map of national intangible cultural heritage the Beijing-Tianjin-Hebei region was drawn (Fig. 3), which reflected the distribution structure characteristics of intangible cultural heritage in Beijing-Tianjin-Hebei region. As shown in the figure, As shown in the figure, there are three high density core areas with Beijing, Tianjin and Handan City as the axis, and five sub-density areas including Baoding, Shijiazhuang, Langfang, Cangzhou and Xingtai.. Further, the average nearest neighbor distance of national intangible cultural heritage in Beijing, Tianjin and Hebei was calculated by spatial statistical tools, and the nearest neighbor index R was 0.55 < 1, indicating that the intangible cultural heritage belongs to the condensed distribution type, showing the characteristics of wide distribution and local concentration. The topography of the Beijing-Tianjin-Hebei region is quite different from north to south and from east to west. The terrain in the northwest is high and dominated by mountains, while the terrain in the southeast is low and dominated by plains. The west follows the Taihang Mountains, the north follows the Yanshan Mountains, and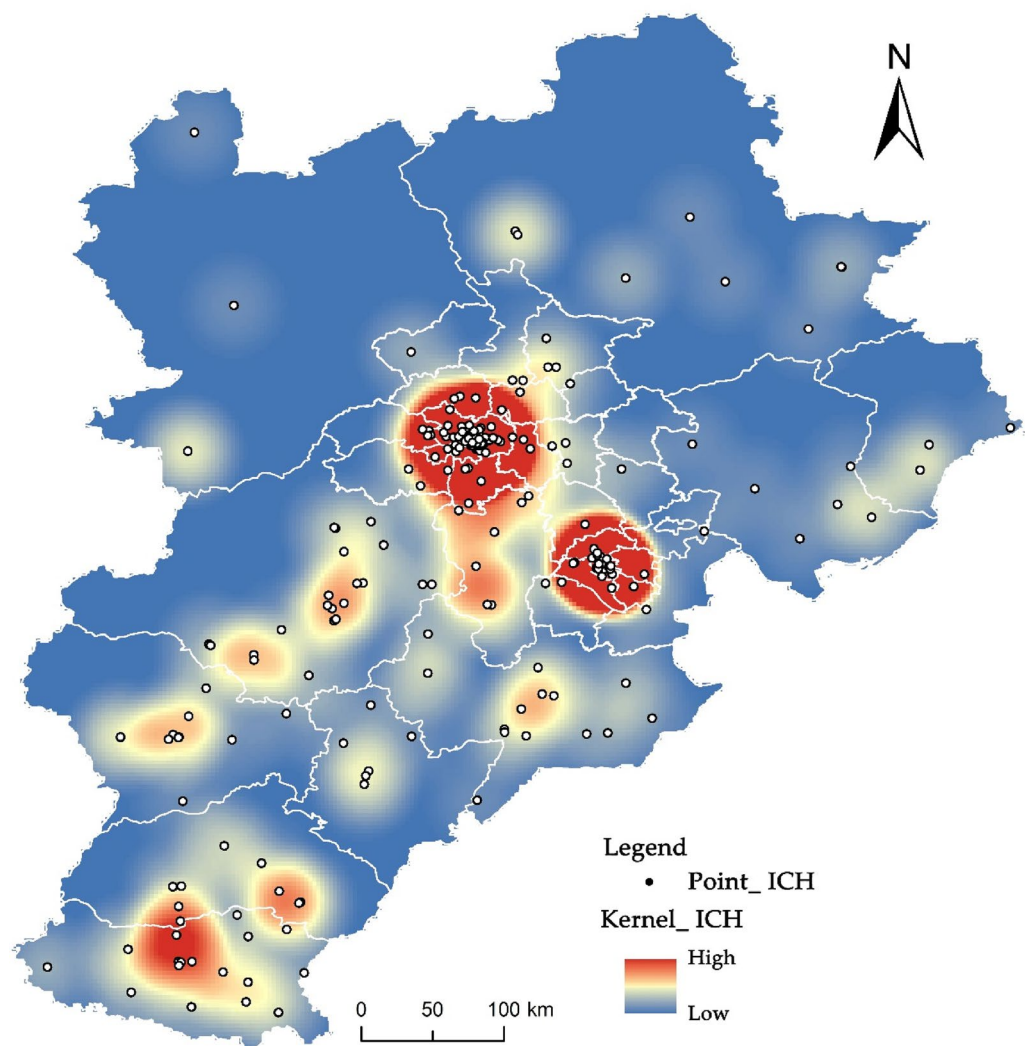 the southeast is the North China Plain. The average elevation of plains in Beijing-Tianjin-Hebei ranges from 0 to 60 m, and the average elevation of mountains ranges from 1000 to 1500 m. Generally, the higher the altitude of the terrain, the smaller the number of people gathered, and the more difficult it is to have the conditions to form intangible cultural heritage. Therefore, intangible cultural heritage is mostly distributed in the southeast and less in the northwest. Beijing and Tianjin are the most concentrated, with more than half of the intangible cultural heritage gathered. Zhangjiakou, Qinhuangdao, Tangshan and Chengde, which have a small amount of intangible cultural heritage, have a large space for the excavation of intangible cultural heritage, need to pay more attention and protection.

Further, the ten types of intangible cultural heritage are counted to obtain the nearest neighbor index table (Table 2). The results show that there are obvious differences in the distribution of various types of intangible cultural heritage. The nearest neighbor index of traditional techniques, art, dramatic balladry, sports, music, and medicine is between 0.5 and 0.8, showing the characteristics of aggregation distribution in space. Among which the aggregation of traditional medicine is the most obvious, and the aggregation of art and music is weak. The nearest neighbor indices of folkways, dance, and

Table 1 Types and Geographical Quantity Distribution of Intangible Cultural Heritage

Geographical Area	Techniques	Art	Dance	Drama	Medicine	Sports, Amusement, Acrobatics	Music	Folk Literature	Folkways	Dramatic Balladry	Total	Area(10000 km²)	Density(Item/10000 km²)
Beijing	41	18	9	5	9	12	4	8	7	7	120	1.641	73.13
Tianjin	8	3	1	4	8	8	5	1	2	7	47	1.197	39.26
Hebei Province	21	15	11	36	4	24	23	5	14	9	162	18.88	8.58
Total	70	36	21	45	21	44	32	14	23	23	329	21.718	15.15

Fig. 3 Kernel density of the national intangible culture heritage in Beijing-Tianjin-Hebei Region

Table 2 The nearest neighbor index of intangible cultural heritage in Beijing-Tianjin-Hebei

Type/Analysis	Average Nearest-Neighbor Distance(km)	Expected Nearest-Neighbor Distance(km)	R	P Value	Z Value	Distribution pattern
Techniques	18.82	27.85	0.68	0	− 5.192	Aggregation
Art	29.53	38.84	0.76	0.006	− 2.753	Aggregation
Folkways	49.28	48.59	1.01	0.895	0.132	Random Distribution
Dramatic Balladry	30.06	48.59	0.62	0	− 3.498	Aggregation
Sports,Amusement,Acrobatics	24.36	35.13	0.69	0	− 3.891	Aggregation
Folk Literature	88.81	62.27	1.43	0.002	3.05	Uniform Distribution
Dance	52.35	50.85	1.03	0.796	0.258	Random Distribution
Drama	35.29	34.74	1.02	0.837	0.206	Random Distribution
Music	30.63	41.85	0.73	0.004	− 2.855	Aggregation
Medicine	26.17	52.1	0.5	0	− 4.259	Aggregation
Total	7.04	12.89	0.55	0	− 15.705	Aggregation

drama are close to 1, tending to be randomly distributed. The nearest neighbor index of literature is greater than 1, showing uniform distribution characteristics. Overall, a total of 226 items of intangible cultural heritage belong to agglomerative distribution characteristics, 89 items belong to random distribution characteristics, and 14 items belong to uniform distribution characteristics.
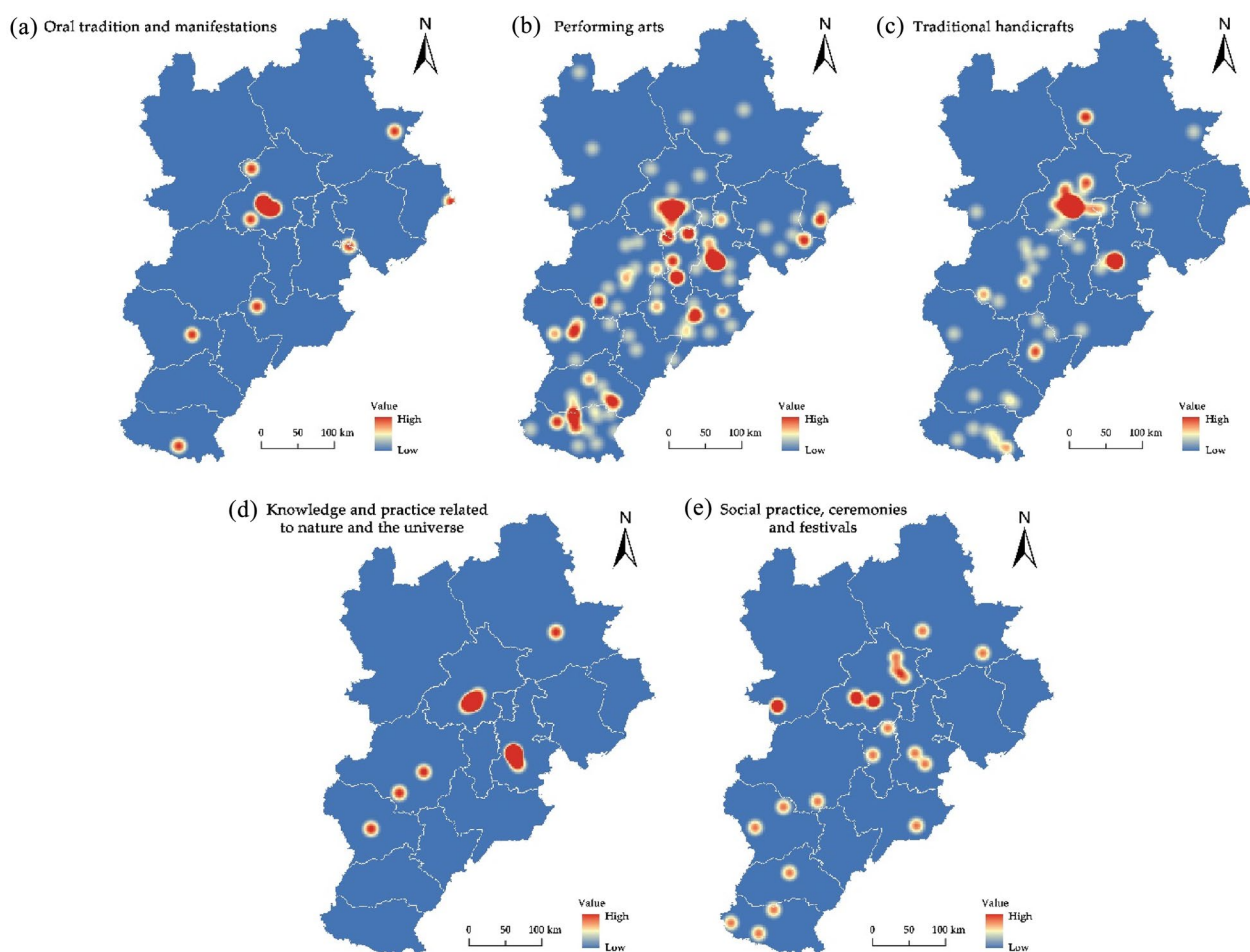
Different types of distribution characteristics

Different countries have different nationalities, histories and cultures, so there are obvious differences in the classification of intangible cultural heritage. For ease of understanding, the ten types of intangible cultural heritage in China are now rearranged according to the classification of the Convention for the Protection of Intangible Cultural Heritage. The following five categories are derived: oral tradition and manifestations (folk literature), performing arts (traditional music, traditional dance, Dramatic Balladry, traditional drama, traditional sports, amusement, and acrobatics), traditional handicrafts (traditional art, traditional techniques), knowledge and practice related to nature and the universe (traditional medicine), social practice, and ceremonies and festivals (folkways). Different types of intangible cultural heritage have different aggregation areas (Fig. 4).

Oral tradition and manifestations are few in number and widely distributed. A high-density area has been formed in Beijing, and a small number of other intangible cultural heritage have not formed a high-density area. In addition, many cities do not have such intangible cultural heritage. (Fig. 4a).

The largest number of performing arts are distributed in each city. Mainly concentrated in the central and southern regions, high-density core areas are formed in Beijing-Tianjin-Langfang City, Hebei Province, and Handan City, Baoding City, Shijiazhuang City and Cangzhou City in the southern region have formed multiple sub-high-density areas. In addition, Tangshan City and Qinhuangdao City in the eastern region also form two sub-high-density areas. (Fig. 4b).

Fig. 4 Distribution characteristics of different types of intangible cultural heritage in Beijing-Tianjin-Hebei Region

Traditional handicrafts are mainly concentrated in Beijing and Tianjin, followed by Chengde City and Hengshui City in Hebei Province to form two secondary high-density areas, in addition. The remaining intangible cultural heritage is widely distributed in other cities in Hebei Province, with the most distribution in southern cities, such as Handan, Baoding and Xingtai, while the number of intangible cultural heritage in northern cities is rare, and Qinhuangdao has none (Fig. 4c. Knowledge and practice related to nature and the universe, such intangible cultural heritage is difficult to inherit, and the number is small. Two high-density areas are formed in Beijing and Tianjin, and three sub-density areas are formed in Baoding, Shijiazhuang and Chengde in Hebei Province. In addition, many cities do not have such intangible cultural heritage. (Fig. 4d).

Social practice, and ceremonies and festivals, forming two high-density areas in southern Beijing and Zhangjiakou City in Hebei Province. In addition, two sub-density areas are formed in the northeast of Beijing and Tianjin. Qinhuangdao City, Tangshan City, and Hengshui City have no such intangible cultural heritage (Fig. 4e. Ancient China was an agrarian society, and the ancient people relied on the North China Plain in the southeastern region, where the flat terrain was good for farming, irrigation, and convenient transportation, facilitating the gathering of people. Stable production methods have produced rich living customs and frequent interaction between cultures, forming local folk art. On the other hand, the northwest region is a high-altitude mountainous area with closed transportation and sparse population, lacking cultural interaction. In general, each type of intangible cultural heritage is mainly concentrated in the central and southern regions of Beijing, Tianjin and Hebei, and the number of intangible cultural heritage in northern cities is scarce. It is necessary to strengthen the exploration of intangible cultural heritage, and improve the awareness of protection to further achieve sustainable inheritance.

Quantitative structure characteristics of spatiotemporal evolution

Quantitative structural characteristics of spatiotemporal evolution

Studying the historical timeline of intangible cultural heritage and understanding the formation period, development period and climax period of each intangible cultural heritage is conducive to long-term historical protection and sustainable development.

Beijing-Tianjin-Hebei has a long history and can be divided into 6 stages according to the historical period: The Beginning of the Great Convergence (Neolithic Age to Xia-Shang period), Cultural Exploration Period (the Spring and Autumn to pre-Qin period), Cultural Development Period(Qin Dynasty to Tang Dynasty), Cultural Prosperity Period (Song, Liao and Jin Dynasties), Synergistic Development Period(Yuan-Ming-Qing Dynasties), The Period of Regional Cultural Integration(Republic of China to Modern Times) [65]. The six historical stages and ten types of intangible cultural heritage were counted, and the distribution of their historical time evolution characteristics was obtained (Table 3). It can be seen that there are obvious differences in the number of intangible cultural heritage formed in different historical periods, and they are greatly influenced by history. There are 9 intangible cultural heritages (accounting for 2.7%) that originated in The Beginning of the Great Convergence, and the number is the smallest. During this period, there were early activities of human life and hunting in the Beijing-Tianjin-Hebei region, and the intangible cultural heritage was mainly traditional sports, amusement, acrobatics. There are 10 intangible cultural heritage items (accounting for 3%) that originated in the Cultural Exploration Period. The number of traditional techniques and traditional sports, amusement, acrobatics has increased more. The appearance of inkstones represents the progress of civilization in this period. During the Cultural Development Period, the number of intangible cultural heritage increased significantly, with a total of 26 items (accounting for 7.9%), traditional music and traditional art began to appear on a large scale, and the lives of citizens were influenced by religion, giving rise to intangible cultural heritage s such as Taoist music and Buddhist statue carving. During the cultural prosperity period, the number of intangible cultural heritage increased steadily, with a total of 22 items (accounting for 6.7%). With the gradual migration of minority groups from the north to the south, which brought diverse cultures, traditional dramas have been greatly developed, such as the world-famous Yangge opera. The number of intangible cultural heritage in the Synergistic Development Period reached its peak, with a total of 251 items (accounting for 76.3%). During this period, Beijing, as the capital, not only drove the development of Tianjin and Hebei, but also promoted the increase in the number of various types of intangible cultural heritage. Techniques and drama are the mainstays. During the Period of Regional Cultural Integration, due to the short historical period, the number of intangible cultural heritage increased slowly, with only 11 items (accounting for 3.3%).

Distribution structure characteristics of spatiotemporal evolution

The essence of intangible cultural heritage is a living cultural product that gathers the ancient people's yearning for a better life and meets their spiritual needs. The

Table 3 Distribution of national-level intangible cultural heritage in various historical periods

Historical Evolutionary Stages	Total	Techniques	Art	Dance	Drama	Medicine	Sports, Amusement, Acrobatics	Music	Folk Literature	Folkways	Dramatic Balladry
The Beginning of the Great Convergence	9	1	1	0	0	2	3	1	0	1	0
Cultural Exploration Period	10	3	0	0	0	0	3	1	2	1	0
Cultural Development Period	26	8	4	0	1	1	1	5	2	3	1
Cultural Prosperity Period	22	2	4	2	5	0	4	1	3	1	0
Synergistic Development Period	251	52	27	18	38	17	30	24	6	17	22
The Period of Regional Cultural Integration	11	4	0	1	1	1	3	0	1	0	0
Total	329	70	36	21	45	21	44	32	14	23	23

formation and development of any intangible cultural heritage cannot be separated from the progress of the times. The kernel density analysis of 329 intangible cultural heritages in Beijing-Tianjin-Hebei region was conducted in six historical periods (Fig. 5), in order to analyze the distribution structure characteristics of spatial and temporal evolution.
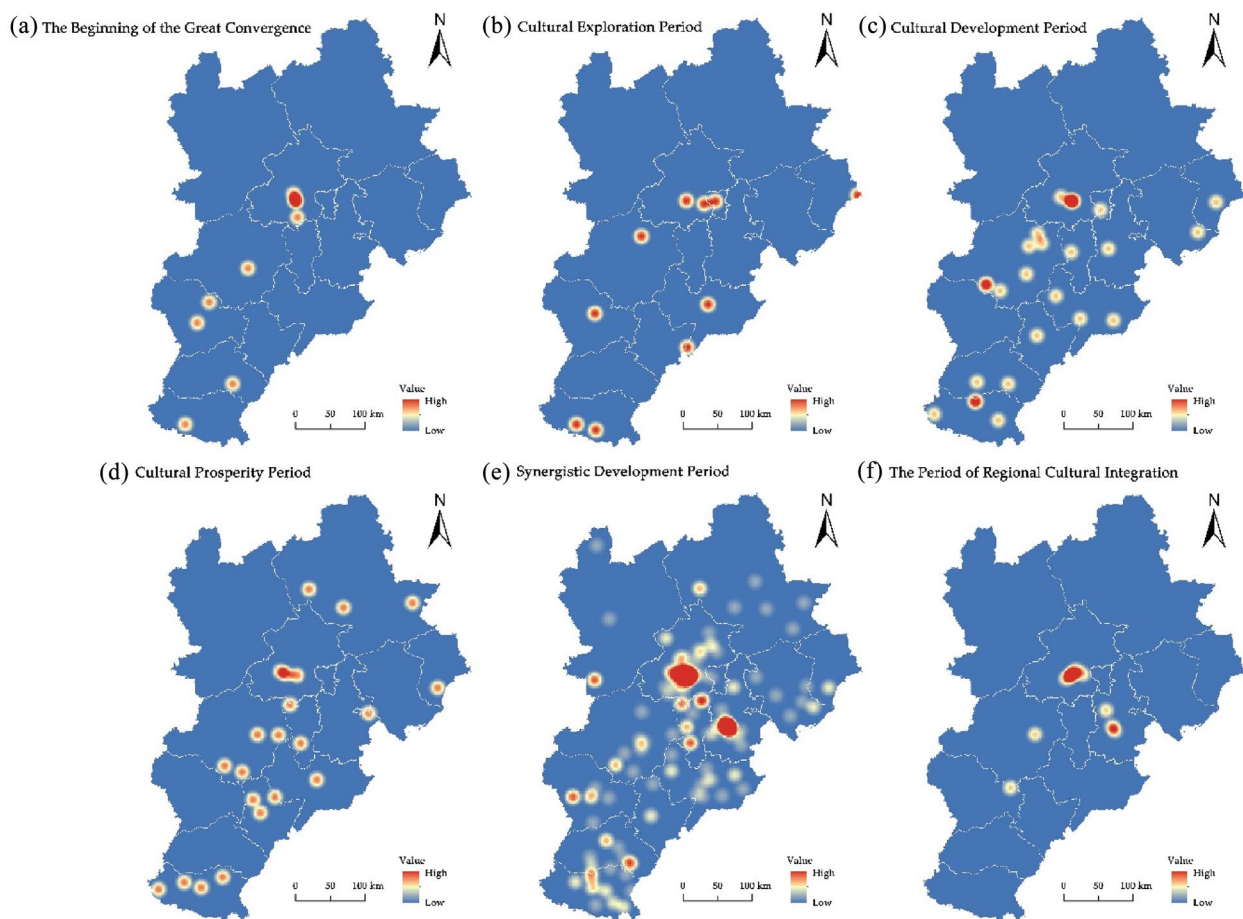
The Beginning of the Great Convergence, the number of intangible cultural heritage at this stage is small and the distribution is scattered. In the Neolithic Age, early human activity was already present in the Beijing-Tianjin-Hebei region, and relying on the natural environment such as the Taihang Mountains, the primitive human group hunting and basic living were satisfied, laying the foundation for the development of intangible cultural heritage with the Beijing Plain as the core. Later, with the emergence of cities, the number of intangible cultural heritage began to grow slowly. (Fig. 5a).

For the Cultural Exploration Period, the number of intangible cultural heritage is mostly in Beijing and Handan City in Hebei Province, while the rest were scattered in other cities. During this period, the two major political, economic, military, and cultural centers of the Beijing-Tianjin-Hebei region were Ji (now Beijing) in the State of Yan and Handan in the State of Zhao (Fig. 5b).

During the Cultural Development Period, the number of intangible cultural heritage showed significant growth, gradually forming a distribution characteristic of local concentration and three high-density areas in Beijing, Baoding City and Handan City of Hebei Province. The Qin Dynasty destroyed the Six Kingdoms and established the first great unified dynasty, and then the development of the Han and Tang Dynasties showed the basic outline of the later Beijing-Tianjin-Hebei region. At this stage, Beijing became the military town, transportation hub and commercial center of the north. (Fig. 5c).

During the Cultural Prosperity Period, the number of Intangible Cultural Heritage increased steadily, mainly gathered in Beijing, Handan City, Baoding City and Hengshui City of Hebei Province. In addition, intangible cultural heritage appeared for the first time in the northern region. At this stage, nomadic peoples in the north

Fig. 5 The kernel density of intangible cultural heritage of Beijing-Tianjin—Hebei in different historical stages

rose and waged war against the Song Dynasty in the Central Plains; the Liao Dynasty established an accompanying capital in Beijing; later, the Jin Dynasty destroyed the Liao and established a central capital in Beijing, which gradually established Beijing as the political, economic, cultural and military center of the north (Fig. 5d).

During the Synergistic Development Period, the number of intangible cultural heritage showed rapid growth, forming a double core region of "Beijing and Tianjin". In addition, the number of the northern region has increased dramatically. The Yuan Dynasty destroyed the Liao Dynasty and the Song Dynasty, and established the capital in Beijing, which became the capital of China for the first time; the Ming Dynasty moved the capital from Nanjing to Beijing. At the same time, Tianjin rose rapidly, and the number of intangible cultural heritage increased sharply; During the Qing Dynasty, the number of intangible cultural heritage reached a numerical peak (Fig. 5e).

The Period of Regional Cultural Integration, which was a short period, showed a rapid decline in intangible cultural heritage. Beijing was the political and cultural center of the country, while modern industry in Tianjin flourished, showing a distribution structure of "Beijing as the core and Tianjin as the sub-core" (Fig. 5f).

Further, using the spatial statistical tool of ArcGIS 10.2, the spatial evolution of the center of gravity of the intangible cultural heritage in each historical stage is obtained.

Further, using the spatial statistical tool of ArcGIS 10.2, the spatial evolution of the center of gravity of the intangible cultural heritage in each historical stage is obtained (Fig. 6). The standard deviation ellipse shows a north–south trend, which is generally a dynamic historical migration of "north–south-north". First of all, from the beginning of the great convergence, the cultural exploration period, to the cultural development period, the conflict between the farming culture of the Central Plains and the nomadic culture of the north continued, and the political changes were frequent, which constituted the accumulation of multi-ethnic cultural exchanges. The center of gravity of intangible cultural heritage in each period is to move to the north. Secondly, from the period of cultural development and cultural prosperity to synergistic development period, when northern minorities rose, migrated southward and established their power in Beijing, the center of gravity moved southward; in the period of regional cultural integration, political stability, the center of gravity of intangible cultural heritage moved to the north again. In general, the historical trajectory of the Beijing-Tianjin-Hebei intangible cultural heritage is affected by regional political development.

From the course of historical evolution, it can be seen that there is a heavy historical origin between Beijing, Tianjin and Hebei. The adjacent geopolitical relationship has divided Beijing, Tianjin and Hebei from each other in history, but also integrated with each other, forming today's Beijing-Tianjin-Hebei region with close relationships, regional integration and cultural ties.
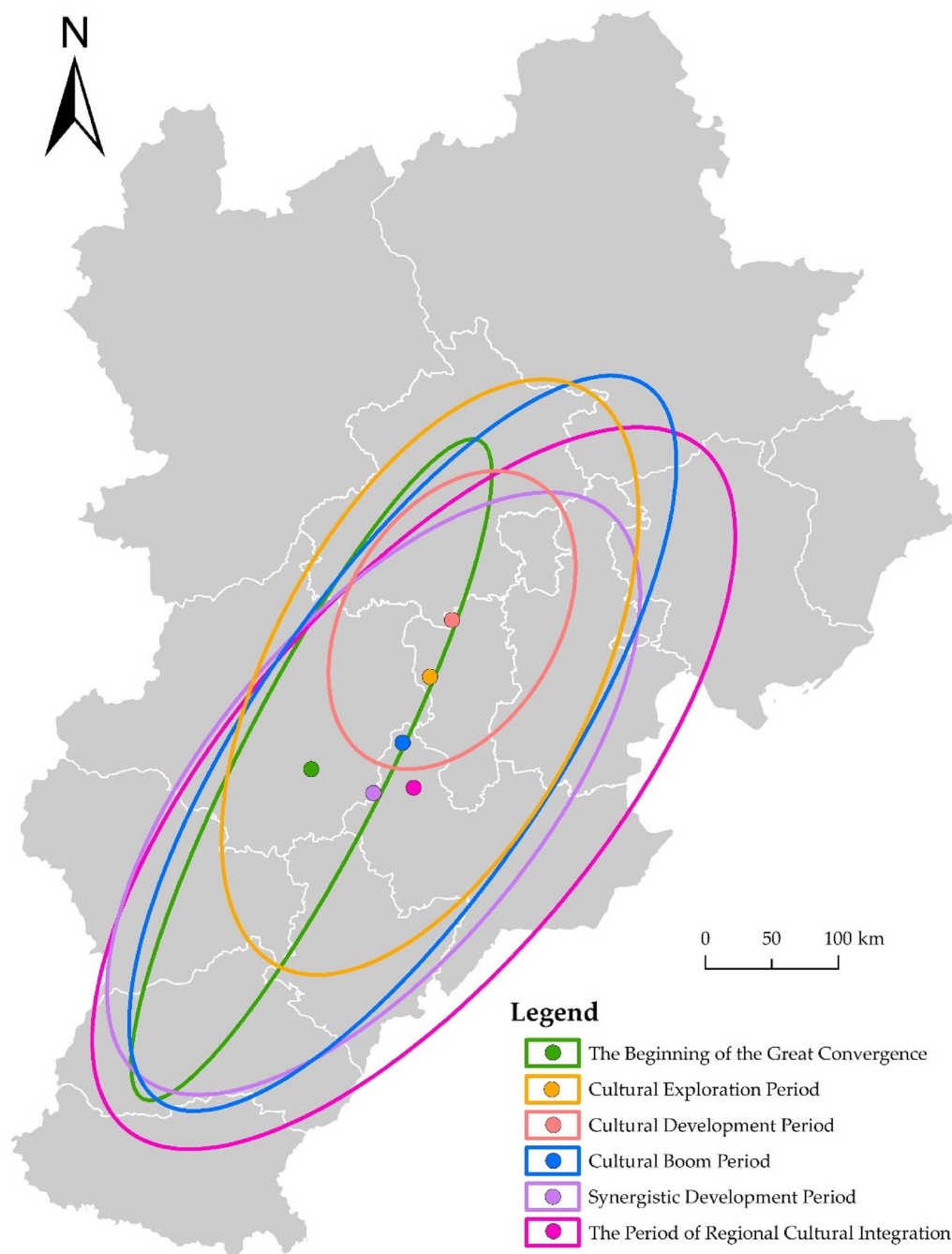
Influencing factors of spatial distribution

The formation and evolution of intangible cultural heritage are closely related to the time and space in which it is located, and are affected by multiple factors such as natural environment, cultural background, and social economy. Based on the research on the structural distribution characteristics, regional distribution characteristics and temporal distribution characteristics of the Beijing-Tianjin-Hebei region, the correlation effects of the spatial distribution of intangible cultural heritage in China's Beijing-Tianjin-Hebei region are analyzed from three dimensions: physical geography, social culture, and economic development. The data of the natural geographical environment are terrain elevation and surface water. Social and cultural data is the sum of museums, memorials, and cultural centers. The data of economic development are total DPG, total population, transportation, urbanization and industrialization. Taking Beijing-Tianjin-Hebei intangible cultural heritage as the dependent variable, combined with 8 independent variables in three dimensions, and using the geographic detector method, the correlation effects of different dimensions and factors with the spatial distribution characteristics of Beijing-Tianjin-Hebei intangible cultural heritage are calculated.

Analysis of influencing factors

Through geographic detectors, the q-value effects of various dimensions and indicators on the spatial distribution of Beijing-Tianjin-Hebei intangible cultural heritage were calculated (Table 4). There are great differences in the influence degree of the q value of different dimensions and different indicators. In terms of dimensions, the influence of economic development ranks first, social culture ranks second, and physical geography ranks third. From the perspective of various indicators, the influence ranking of the spatial distribution of Beijing-Tianjin-Hebei intangible cultural heritage is: total GDP (0.8556) > urbanization (0.786) > cultural institutions (0.7391) > total population (0.7388) > industrialization (0.6375) > surface water (0.5431) > terrain elevation (0.1152) > transportation (0.0528).

Physical geography is the basic condition for the formation of intangible cultural heritage. Ancient China was an agrarian society. The ancients in the Beijing-Tianjin-Hebei region relied on the superior natural and geographical conditions of the North China Plain. The flat terrain was good for farming, irrigation and water conservancy, and convenient transportation, which

Fig. 6 Elliptical difference and center of gravity distribution of intangible cultural heritage in Beijing-Tianjin-Hebei Region

promoted the gathering of the population. Stable production methods have nurtured rich living customs, frequent exchanges between cultures, and fusion into local intangible cultural heritage. Therefore, it is mainly concentrated in the North China Plain, with abundant water resources, with the most in the Beijing Small Plain and the Tianjin Alluvial Plain, while the number

of intangible cultural heritage located in the northern and western mountains is relatively small. Terrain elevation (0.1152), as a natural geographical element, has a certain influence on the intangible cultural heritage, but the degree is not large. Surface water (0.5431) has a great influence on the spatial distribution of Beijing-Tianjin-Hebei intangible cultural heritage. Due to the

Table 4 Influencing factors and its determinant values

Dimension	Indicator factors	Data Sources	q	p
Physical	Terrain elevation	Dem data	0.1152	0.0000
	Surface water	Official statistics	0.5431	0.0000
Socio-cultural	Cultural institutions (museums, cultural centers, memorials)	Official statistics	0.7391	0.0000
				0.0000
				0.0000
Economic	Total GDP	Official statistics	0.8556	0.0000
	Total population	Official statistics	0.7388	0.0000
	Transportation	Official statistics	0.0528	0.0000
	Urbanization	Official statistics	0.786	0.0000
	Industrialization	Official statistics	0.6375	0.0000

lack of water resources, the water area in the region has obvious advantages.

Social culture is the essential attribute of intangible cultural heritage, which mutually influences and promotes each other. The magnitude of the social and cultural influence value reflects the importance that the local government attaches to intangible cultural heritage. The impact value of Beijing-Tianjin-Hebei cultural institutions (0.7391) ranks third, indicating that social culture has a great influence on the spatial distribution of intangible cultural heritage. The higher the cultural level, the more conducive to the protection and inheritance of intangible cultural heritage.

Economic development is closely related to the evolution of intangible cultural heritage, and economic factors have an important impact on the spatial distribution of intangible cultural heritage. total GDP, urbanization, total population and Industrialization, all four influencing factors have high q-values, and only Transportation has a lower q-value, indicating that economic factors have

a high influence on the spatial distribution of Beijing-Tianjin-Hebei intangible cultural heritage. Regions with a high level of economic development, such as Beijing and Tianjin, are more likely to form high-density areas of intangible cultural heritage.

Interaction analysis of influencing factors

Using geographic detectors, the interaction of different influencing factors on the spatial distribution of Beijing-Tianjin-Hebei intangible cultural heritage was obtained (Table 5). There are two types of interaction, nonlinear-enhancement and bi-enhancement, to evaluate whether different independent variables will change the influence on the dependent variable when they act together.

From the results of interaction detection, it can be seen that the influence of the intersection of two factors is greater than that of a single factor, which is consistent with the multi-factor cross-influence characteristics of the spatial distribution of

Table 5 Results of interaction between different Influencing factors

Indicator factors	Terrain elevation	Surface water	Total GDP	Total population	Transportation	Cultural institutions	Urbanization	Industrialization
Terrain elevation	0.1152							
Surface water	0.7404[NE]	0.5431						
Total GDP	0.8702[BE]	0.9569[BE]	0.8556					
Total population	0.7886[BE]	0.8697[BE]	0.9580[BE]	0.7388				
Transportation	0.3255[NE]	0.9174[NE]	0.9161[NE]	0.8900[NE]	0.0528			
Cultural institutions	0.7872[BE]	0.8699[BE]	0.9483[BE]	0.7608[BE]	0.8424[NE]	0.7391		
Urbanization	0.8130[BE]	0.9341[BE]	0.9760[BE]	0.9099[BE]	0.9540[NE]	0.8817[BE]	0.7860	
Industrialization	0.6944[BE]	0.8796[BE]	0.9025[BE]	0.7960[BE]	0.9336[NE]	0.8216[BE]	0.8164[BE]	0.6375

NE denotes Nonlinear-Enhancement, *BE* denotes Bi-Enhancement

Beijing-Tianjin-Hebei intangible cultural heritage, and the type of influence is mainly bi-enhancement, followed by nonlinear-enhancement.

For example, the q-value of Terrain elevation and Transportation factors is not high, and the influence of a single factor is very small, but after interacting with other factors, it shows an enhancement effect, and its influence on the spatial distribution of Beijing-Tianjin-Hebei intangible cultural heritage becomes larger. In addition, the interaction between total GDP and other factors has the highest influence, and the q-value of total GDP and total population is 0.9580, which is the pair with the largest q-value among all interaction factors, indicating that the combined effect of the two is more effective than other combinations on the Beijing-Tianjin-Hebei intangible cultural heritage. The q-value of Terrain elevation and transportation is the smallest, which is 0.3255, indicating that the combined effect of the two is small. In general, the proper understanding and protection of intangible cultural heritage and sustainable development are inseparable from the comprehensive consideration of the three dimensions of physical geography, social culture and economic development.

Conclusion and discussion
Conclusion
Through different types of spatial analysis methods, this paper analyzes the spatial distribution characteristics and influencing factors of 329 national intangible cultural heritage items in Beijing-Tianjin-Hebei China. Among them, the spatial distribution characteristics take structural distribution, regional distribution and spatiotemporal evolution distribution as the breakthrough point, and the influencing factors take physical geography, social culture and economic development as the breakthrough point. Concluded as follow:

1) There are significant differences in the structural types of national intangible cultural heritage in the Beijing-Tianjin-Hebei region. Among the ten types, only traditional arts and traditional music have a relatively balanced number, while the rest have the largest number of traditional techniques and the least number of folk literatures. Among them, Beijing has the largest number of traditional techniques, Tianjin has the largest number of traditional techniques, sports, amusement and acrobatics, Hebei has the largest number of traditional dramas.

2) The distribution of national intangible cultural heritage in the Beijing-Tianjin-Hebei region has obvious aggregation characteristics. It is mainly distributed in the central and southern regions of Beijing-Tianjin-Hebei, with few distributions in the northern region.

Two high-density core areas are formed in the central area, and one high-density core area and five sub-density core areas are formed in the southern area. Among them, traditional techniques, traditional arts, dramatic balladry, sports, music, and medicine showed the characteristics of aggregation distribution, folkways, dance, and drama showed the characteristics of random distribution; and folk literature showed the characteristics of uniform distribution.

3) There are differences in the distribution of time and space of the national intangible cultural heritage in Beijing-Tianjin-Hebei. The intangible cultural heritage in different historical stages is influenced by the economy, culture and politics of the period. The six historical stages division referenced in this study is derived from the book "Common History of Beijing Tianjin and Hebei " jointly published by the Capital Museum, Tianjin Museum and Hebei Museum. The conclusion shows that intangible cultural heritage grows slowly in the Beginning of the Great Convergence and Cultural Exploration Period, grows rapidly in Cultural Development Period and Cultural Prosperity Period, reaches the peak value in Synergistic Development Period, and in Period of Regional Cultural Integration, the growth rate is slow due to the short period of time. Overall, it presents a dynamic historical migration of " north–south-north ". In addition, the main types of intangible cultural heritage are different in each historical stage.

4) The spatial distribution of national intangible cultural heritage in Beijing-Tianjin-Hebei is affected by the intersection of multiple dimensions of physical geography, social culture and economic development. Through the geographic detector, the influence of different factors on the spatial distribution of intangible cultural heritage is analyzed from two aspects: single factor and cross factor. In general, the influence of GDP value is the largest and has the greatest interactive influence with other factors, while the influence of transportation and the influence of topographic elevation are relatively small, but they are still factors that cannot be ignored in the sustainable development of intangible cultural heritage.

Discussion
As living cultural heritage, the formation and development of intangible cultural heritage embodies thousands of years of cultural genes, spiritual core, values and other factors of the Chinese nation. The history of each intangible cultural heritage contains a unique regional culture, which is a precious treasure left by history to all mankind.

From the perspective of sustainable development, this paper puts forward suggestions for the protection and development of the Beijing-Tianjin-Hebei intangible cultural heritage:

First, there is a great degree of differentiation in the structure type, distribution space and living environment of intangible cultural heritage in Beijing-Tianjin-Hebei. The west and north are mountainous areas with high altitude, limited agricultural production, blocked traffic, slow economic development, and very few intangible cultural heritages, but a large number of traditional villages are located here, forming a unique mountain culture. Financial investment and exploration work in this region should be strengthened to alleviate the current situation of unbalanced distribution of intangible cultural heritage.

Second, for areas with a high concentration of intangible cultural heritage, the government can encourage capital intervention, combined with all-for-one tourism and active development, which can not only improve people's awareness of cultural protection, but also obtain funds for later maintenance. Reasonable protection and development can achieve a virtuous circle of sustainable development.

Third, from the perspective of history, intangible cultural heritage is inherited and developed. Today, with economic development as the main theme, strengthening the protection of the natural ecological environment and paying attention to the spread of cultural awareness have important practical significance for the sustainable development of intangible cultural heritage.

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Conceptualization, L.P. and L.W.; methodology, L.P.; software, L.P.; validation, L.P.; formal analysis, L.P.; investigation, L.P.; resources, L.P.; data curation, L.P and L.W.; writing—original draft preparation, L.P.; writing—review and editing, L.P.; visualization, L.P.; supervision, L.P.; All authors have read and agreed to the published version of the manuscript. All authors read and approved the final manuscript.

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