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Study on the Spatiotemporal Characteristics and Correlation of the Meteorological Disasters and Plague Epidemics in Ming and Qing Dynasties in China

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Abstract

Objective: To clarify the spatiotemporal characteristics of meteorological disaster changes and plague epidemics during the Ming and Qing Dynasties in China, as well as their correlation. Method: The occurrence time and meteorological types of meteorological disasters during the Ming and Qing Dynasties were collected based on the background data of 'General Collection of Meteorological Records of China for Three Thousand Years' and 'Chronology of Epidemic in Ancient China'; Frequency, exploratory factors, decision trees, and other analyses were conducted using Excel 2016, IBM SPSS Statistics 25.0, and AMOS24.0 software to analyze the occurrence time and location of the epidemic. Result: The frequency of meteorological disasters in various provinces during the Ming and Qing dynasties, from high to low, was as follows: Shandong, Hebei, Jiangsu, Zhejiang, Henan, Guangdong, Shanxi, Anhui, Jiangxi, Hubei, etc., with the highest frequency in East China and the lowest in Northeast China. The frequency of meteorological disasters from high to low is: rainstorm flood, drought, hail, wind, snow, frost, cold, fog, warm/hot, and the impact of rainstorm flood and drought is more severe than other meteorological disasters. The frequency of plague outbreaks in various provinces of China during the Ming and Qing dynasties, from high to low, was as follows: Zhejiang, Fujian, Hebei, Shandong, Henan, Jiangsu, Jiangxi, Hubei, Shanxi, Anhui, etc. Nine common factors were extracted from the plague epidemic areas, which basically conform to the epidemic characteristics of geographically close areas. The meteorological disaster factors most closely related to the occurrence of plague in the Ming and Qing dynasties are gale and rainstorm flood. The plague epidemic in factor 1 area is affected by the type of meteorological disasters, which are wind, hail, rainstorm flood, snow, drought, etc. Conclusion: With the increase of meteorological disasters during the Ming and Qing dynasties, the occurrence and prevalence of epidemics intensified, and the epidemic of epidemics had obvious regional distribution and characteristics of meteorological disaster types.

Keywords

Ming and Qing Dynasties; Plague; Meteorological; Data Mining.

1. INTRODUCTION

The Ming and Qing Dynasties were the peak period for the outbreak of plague in China. For more than 500 years, the frequent occurrence of meteorological disasters such as wind, flood, drought, waterlogging, hail and so on led to the spread and torture of natural disasters, which

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led to the widespread epidemic of pestis, cholera, smallpox, dysentery and other severe plagues in China, killing countless people. This caused immeasurable losses to the social economy of the Ming and Qing Dynasties, and also promoted the unprecedented development of plague diagnosis and treatment theory and prevention technology in the Ming and Qing Dynasties. This study aims to elucidate the characteristics and changing patterns of meteorological disasters, as well as the time and regional characteristics of the occurrence and spread of epidemics, in the context of the Ming and Qing Dynasties epidemic era in China (1368-1912 AD). It aims to clarify the differences in the degree of influence of meteorological disasters on different epidemic areas, and explore methods for epidemic warning in the future, and guide the prevention and control of modern traditional Chinese medicine diseases.

2. DATA COLLECTION AND ORGANIZATION

Comprehensive retrieval of meteorological disaster data from the Ming and Qing dynasties (1368-1912 AD) in the ‘General Collection of Meteorological Records of China for Three Thousand Years’ [1]. Using "year" as the basic unit, detailed information on the occurrence time and meteorological types (wind, rain, snow, ice, hail, cold, temperature, drought, flood) of meteorological disasters is extracted. Unified and standardized terminology description, flood, water overflow, water gushing, river break, river overflow, sea overflow, collectively referred to as rainstorm and flood; No rain or severe drought, collectively referred to as drought; Rain wood ice, called frost; Hurricanes and strong winds are collectively referred to as winds; Heavy fog and black air are collectively referred to as fog; Rain hail, wind hail, and hail are collectively referred to as hail; Rain, snow, and yin are collectively referred to as cold. At the same time, based on the ‘Chronology of Epidemic in Ancient China’ [2], collect information on the time and location of plague occurrence. Those who have been confirmed as infectious diseases, such as "acne" - smallpox, “diaojiaosha” - cholera, and other characteristics with heavy casualties, will be included in the income; Uncertain individuals, such as typhoid fever, seasonal factors, etc., may be eligible for income if there is a clear infection or epidemic. When recording the frequency of epidemics, a relatively independent year or place is used to calculate the frequency of epidemics. Calculate the annual outbreaks of epidemics in a certain area without interruption. If there is a simultaneous outbreak of epidemics in multiple places within the same year or consecutive years, it shall be calculated once. And maintain the above three statistical standards from beginning to end. Referring to the ‘Chinese Ancient Epidemic Epidemic Chronology-Chinese Ancient Epidemic Epidemic Epidemic Chronology Ancient Place Name Preparation’, the corresponding modern provinces and cities with epidemic outbreaks were surveyed. After independent verification of the data by two people, an Excel database was established.

3. STATISTICAL ANALYSIS METHODS

Perform frequency analysis using Excel 2016; Using IBM SPSS Statistics 25.0 software, the exploratory factor analysis extraction method is the Alpha factor method, with expert operation mode. Only complete records are used, with a maximum convergence iteration of 25. Factors with eigenvalues greater than 1 are extracted, and the Quadrimax maximum value method is used to rotate the component matrix, hiding factor loadings less than 0.1. Decision tree analysis uses a hierarchical decomposition method to handle multi class problems by generating multiple decision trees. Establish a structural equation measurement model using AMOS24.0 software.

4. RESEARCH RESULTS

4.1. The spatiotemporal characteristics of meteorological disasters in China during the Ming and Qing dynasties

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4.1.1 Frequency analysis of meteorological disaster types in China during the Ming and Qing dynasties

Taking 10 years as the time unit, the frequency analysis results show that the frequency of meteorological disasters from high to low is: rainstorm flood, drought, hail, wind, snow, frost, cold, fog, warm/hot. It can be clearly seen from Figure 1 that rainstorm floods and droughts in each period are characterized by high incidence, and the occurrence of extreme cold and warm is far lower than other types of disasters.

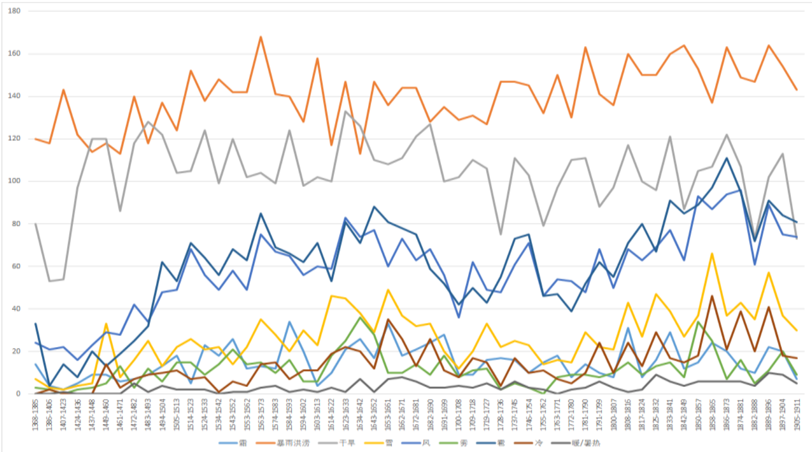

Figure 1 Line chart of meteorological disaster types during the Ming and Qing dynasties

4.1.2 Frequency analysis of meteorological disaster types in various provinces of China during the Ming and Qing dynasties

The frequency of meteorological disasters in various provinces during the Ming and Qing dynasties, from high to low, was as follows: Shandong, Hebei, Jiangsu, Zhejiang, Henan, Guangdong, Shanxi, Anhui, Jiangxi, Hubei, Hunan, Fujian, Shaanxi, Guangxi, Sichuan, Yunnan, etc., as shown in Table 1. The occurrence of various meteorological disasters in East China is much higher than that in other regions, while the occurrence of meteorological disasters in Northeast China is the least.

4.2. The spatiotemporal characteristics of plague outbreaks in China during the Ming and Qing dynasties

4.2.1 Frequency Analysis of Plague Epidemic Changes in China during the Ming and Qing Dynasties

Taking 10 years as a time unit, the occurrence and prevalence of epidemics during the Ming and Qing dynasties showed a gradually increasing trend, and there were significant peak changes between 1638-1647, 1818-1827, and 1858-1867, as shown in Figure 2.

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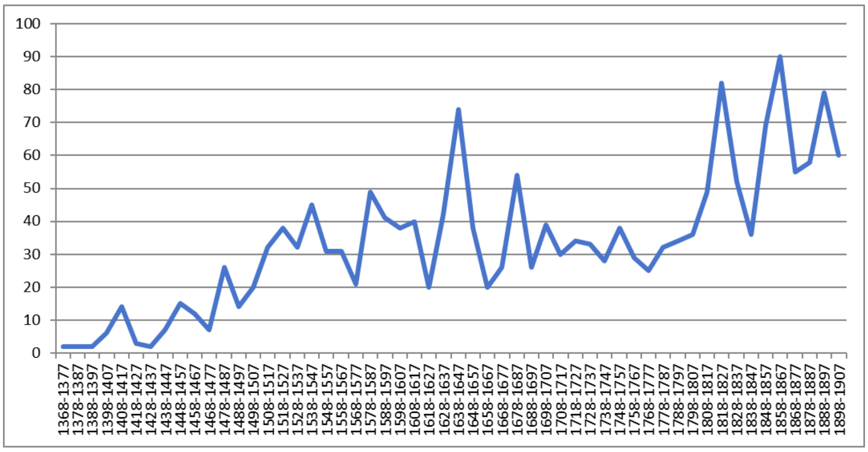

Figure 2 Line Chart of Epidemic Changes during the Ming and Qing Dynasties

4.2.2 Frequency analysis of plague outbreaks in various provinces of China during the Ming and Qing dynasties

The frequency analysis results show that during the Ming and Qing dynasties, Zhejiang Province had the highest number of outbreaks of epidemics, reaching147, indicating that 27.02% of the time during the Ming and Qing dynasties, the region experienced epidemics; Next is the Fujian region, with 126 occurrences, accounting for 23.16% of the Ming and Qing dynasties in the region, as shown in Table 1.

Table 1 Frequency Analysis of Plague Epidemic in Various Provinces of China during the Ming and Qing Dynasties

Region	Count	Percentage%	Region	Count	Percentage%
Zhejiang	147	27.02%	Guangdong	79	14.52%
Fujian	126	23.16%	Shannxi	61	11.21%
Hebei	122	22.43%	Sichuan	55	10.11%
Shandong	121	22.24%	Shanghai	53	9.74%
Henan	121	22.24%	Guizhou	48	8.82%
Jiangsu	112	20.59%	Gansu	35	6.43%
Jiangxi	104	19.12%	Hainan	30	5.51%
Hubei	101	18.57%	Beijing	25	4.60%
Shanxi	100	18.38%	Tianjin	15	2.76%
Anhui	100	18.38%	Taiwan	11	2.02%
Guangxi	87	15.99%	Ningxia	3	0.55%
Yunnan	85	15.63%	Three Eastern Provinces	3	0.55%
Hunan	84	15.44%	Inner Mongolia	2	0.37%

4.2.3 Exploratory Factor Analysis of Plague Epidemic Regions in China during the Ming and Qing Dynasties

The correlation test KMO value of exploratory factor analysis is 0.761, and the approximate chi square value of Bartlett's sphericity test is 2329.896, with a degree of freedom of 406 and significance ($P<0.001$), indicating that the data is suitable for exploratory factor analysis. The common factor extraction method is the main component method, with Kaiser standardized orthogonal rotation method. The results of the scree plot in Figure 3 show that starting from

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the 10th factor, the scree plot tends to flatten. Combined with the rotated component matrix results, it can be classified into 9 factors, cumulative explaining 52.465% of the variance. Among the 9 common factors, except for common factor 5, they basically reflect the characteristics of plague epidemic areas with close geographical locations, as shown in Table 2.

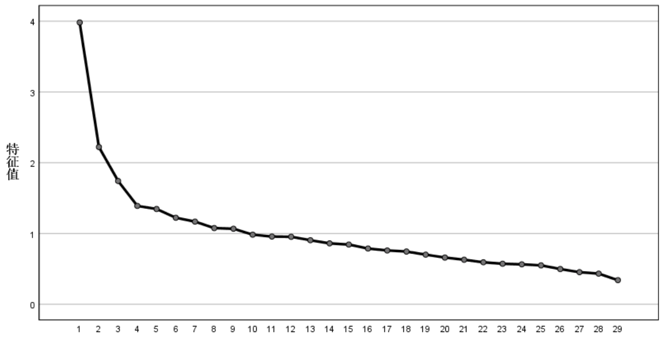

Figure 3 Exploratory factor analysis scree plot

Table 2 Factor Classification of Plague Epidemic Regions in China during the Ming and Qing Dynasties

Factor	Region
1	Hebei, Shandong, Shanxi, Henan
2	Jiangsu, Anhui, Hubei
3	Guizhou, Chongqing, Sichuan, Yunnan
4	Hainan, Guangdong, Guangxi
5	Shannxi, Zhejiang, Shanghai, Gansu
6	Fujian, Hunan, Jiangxi
7	Qinghai, Ningxia
8	Tianjin, Beijing, Three Eastern Provinces, Inner Mongolia
9	Xizang

4.3. Correlation Analysis between Meteorological Disasters and Plague Epidemic in China during the Ming and Qing Dynasties

4.3.1 Decision Tree Analysis of Meteorological Disasters and Plague Epidemic in China during the Ming and Qing Dynasties

Set the occurrence of epidemics as the dependent variable and meteorological disasters as the independent variable, and establish a decision tree model. The model evaluation results show that the estimated value of the Risk statistic of the training samples is 0.111, indicating that the accuracy of the model in predicting the risk of plague occurrence is 88.9%. The results indicate that the model has a good fitting effect. The sensitivity, specificity, and overall accuracy of the training samples were respectively 71.9%, 92.6%, and 88.9%, The sensitivity, specificity, and overall accuracy of the test samples were 60.0%, 93.1%, and 87.3%, respectively. There are four rules: ① Rule 1: there are less than 5 areas with strong wind, and less than 11 areas with rainstorm and flood, and the incidence of plague is 35.1%; ② Rule 2: There are less than 5 areas with strong wind, more than 11 areas with rainstorm and flood, and the incidence of plague is 87.8%; ③ Rule 3: Strong winds occur in areas between 5 and 10, with a plague incidence rate of 92.9%; ④ Rule 4: Gale occurs in more than 10 areas, and the incidence rate

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of plague is 92.3%. See Figure 4 for details, indicating that gale, rainstorm and flood are most closely related to plague.

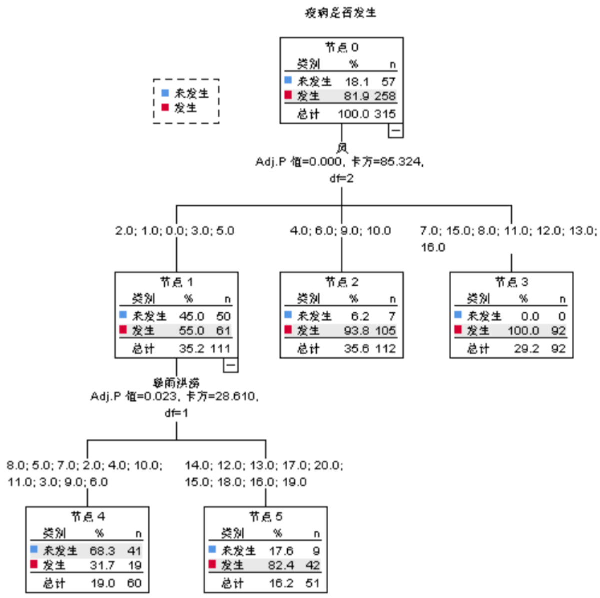

Figure 4 Decision Tree Model of Meteorological Disasters and Plague Epidemic in China during the Ming and Qing Dynasties

5. DISCUSSION

5.1. During the Ming and Qing Dynasties, rainstorm, flood and drought were the most rampant meteorological disasters

In the meteorological disasters during the Ming and Qing Dynasties, rainstorm, flood and drought not only had a high incidence but also had a strong impact. Research by Cha Xiaochun[3] found that flood disasters mainly have drawbacks such as damaging crops, collapsing houses, lack of food and clothing, and even causing a large number of deaths, long-term economic impact, and so on. Xie Hongwei[4] found that during the Ming and Qing Dynasties, therewere mainly three situations: rainstorm, mountain flood, river flood, and urban waterlogging. The flood disaster led to drowning, city wall collapse, bridge collapse, dam washout, and landslide. Gu Shuai[5] found that the occurrence of flood disasters in the Fenhe River during the Ming and Qing dynasties was closely related to climate, terrain, and water system distribution, with meteorological changes being the main factor. Drought can lead to a significant reduction in crop yields and a series of hazards such as fatalities. Yu Yaochuang[6] found that the occurrence of drought in the Weinan region during the Ming and Qing dynasties was closely related to winter temperature changes, and they believed that the occurrence of drought in Weinan during this period was a response to global climate change. Wan Honglian[7] found that the occurrence of drought in the Baoji area during the Ming and Qing dynasties was consistent with the climate change in the Guanzhong area. The drought and flood disasters in Jiangsu Province during the Ming and Qing dynasties were closely related to the "plum rain" season and dry weather in the region, and corresponded to climate change in the middle and lower reaches of the Yangtze River[8].

5.2. The epidemic during the Ming and Qing dynasties had distinct regional characteristics

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The frequency of epidemics is related to factors such as the level of medical treatment and economic situation in each region. Through frequency analysis, it was found that the incidence rates in Beijing and Tianjin were 4.6% and 2.76% respectively. During the Ming and Qing dynasties, the capital was established in Beijing. Considering that the control and treatment of the epidemic in this area are far better than in other areas, Tianjin is adjacent to Beijing. According to the percentage of incidence rate, areas with incidence rate of more than 20%, less than 20%, more than 10% and less than 1% are adjacent to each other, and most of them are developed areas. In areas below 10% and above 1%, each region is not adjacent to each other. Shanghai, Beijing, Tianjin, and Hainan are relatively developed in this region, while Gansu and Guizhou are underdeveloped areas. It is considered that the reason for this result may be related to the record of plague occurrence. At the same time, there is less plague in Qinghai, Inner Mongolia, Xizang and other regions. The above regions are also economically underdeveloped regions, which may also be caused by the lack of epidemic record.

5.3. During the Ming and Qing Dynasties, the main meteorological factors for the epidemic of plague were gale, rainstorm and flood

Wind, rainstorm and flood are the main meteorological factors that cause the occurrence and prevalence of plague, especially the wind has the highest correlation with the occurrence of plague. The "Su Wen-Qi Tong Tian Lun" points out that on the basis of the pathogenic characteristics of wind evil, strong winds and toxins have both toxic properties and stronger infectivity, and they occur quickly and seriously [9]. Therefore, in the process of external pathogenic factors causing diseases, wind evil is prone to be combined with heat evil caused by drought and dampness evil caused by floods, leading to the widespread spread of epidemics. The use of wind medicine can drive out evil in the early stages of an epidemic, prevent invagination and transformation, and can still cut off and reverse the disease after entering the bloodstream. During the recovery period, it can also protect the healthy qi and promote recovery[10]. Therefore, it occupies an important position in the treatment of epidemics. Rainstorm and flood disasters often cause a large number of people to migrate. Pathogenic microorganisms will spread to the flowing areas along with the flow of flood, increasing the contact opportunities between rodents and residents. The victims are vulnerable to blood sucking arthropods, drinking water pollution, food and fuel shortages, which will cause large-scale spread of the plague [11].

6. CONCLUSION

There is a strong correlation between meteorological disasters and the occurrence and spread of epidemics. The changes in meteorological environment affect the occurrence time, manifestation type, epidemic area and scope of epidemics. Based on the meteorological changes and epidemic situation during the Ming and Qing dynasties, this study explores the correlation between meteorological disasters and epidemic patterns, and clarifies the mechanism of meteorological factors on the occurrence and spread of epidemics, which is helpful for the scientific understanding and prevention research of new infectious diseases in the future.

REFERENCE

[1] Zhang D E.(2013).General Collection of Meteorological Records of China for Three Thousand Years [M]. Nanjing: Jiangsu Education Press.

[2] Zhang Z B.(2007).Chronology of Epidemic in Ancient China [M]. Fuzhou: Fujian Science and Technology Press.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202408_10(8).0005

[3] Cha X C, Lai Z L.(2013). Research on Flood Disasters and Their Impact on Social and Economic Development in the Weinan Region during the Ming and Qing Dynasties [J]. Journal of Arid Land Resources and Environment, 27 (04): 59-64.

[4] Xie H W, Gan Q.(2021). Flood Disaster and Coping Mechanism of Jiangxi in Ming and Qing Dynasties [J]. Journal of Jiangxi Normal University(Philosophy and Social Sciences Edition), 54 (04): 126-138.

[5] Gu S, Niu J J, Wang S Y, et al.(2013). A Study on Flood Disaster in the Middle Reaches of the Fen River during the Ming and Qing Dynasties [J]. Journal of Arid Land Resources and Environment, 27 (08): 108-114.

[6] Yu Y C, Wang C Y, Gong L L, et al.(2021). Multi-scale Features of Drought Disasters and Response to Climate Change in Weinan Region during Ming and Qing Dynasties [J]. Acta Agriculturae Jiangxi, 33 (05): 102-108.

[7] Wan H L, Song H L, Zhu C C, et al.(2017). The drought and flood disaster chain in Baoji area during the Ming and Qing dynasties and its response to climate change [J]. Acta Geographica Sinica, 72 (01): 27-38.

[8] Wan H L, Zhu C C, Song H L, et al.(2017). The Relationship between Drought and Flood Disasters and Climate Change in Jiangsu Province during the Ming and Qing Dynasties [J]. Journal of Arid Land Resources and Environment, 31 (12): 104-109.

[9] Zhang J W, Jia W K, Cao W, et al.(2020). Discussion on the Relationship between Pathogenic Wind and Epidemic Disease [J]. Guangming Journal of Chinese Medicine, 35 (18): 2821-2824.

[10] Wang G J, Gong L, Huang T, et al.(2020). Treatment of COVID-19 with Wind Dispelling Medicine [J]. Acta Chinese Medicine, 35 (11): 2279-2284.

[11] Li Y.(2010). A Discussion on Fujian Plague in the Ming Dynasty [J]. Journal of Minjiang University, 31 (03): 130-134.