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Journal of Infectious Diseases

ISSN 2831-8064

Research Article

Epidemiological Characteristics of Anthrax in an Agricultural-pastoral Region of Northeastern China: a 21-year Cross-sectional Study.

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Abstract

Objective: This study analyzed the epidemiological characteristics and epidemic patterns of anthrax in Chifeng of Inner Mongolia in the past 21 years, and explored the current status of anthrax in Chifeng of Inner Mongolia. This study aims to provide a reference for the prevention and control of anthrax in the future.

Method: A total of 145 anthrax cases reported to the China Disease Prevention and Control Information System from 354 medical institutions in Chifeng City from 2004 to 2024 were collected. Microsoft Excel 2019 was used to establish a database for descriptive analysis of the time, region, gender and age of anthrax cases. SPSS 26.0 software was used to analyze the data, and ArcGIS software was used to generate spatial distribution maps.

Results: There were 18 annual reports of anthrax cases in the city, with a total of 145 cases. The reported annual incidence rate ranged from 0.02/100 000 and 0.45/100 000. The epidemic period was mainly from June to October, and the epidemic peaked in August. Anthrax cases were reported in all administrative regions except J administrative region, which was an urban area and the rest were farming and animal husbandry areas. The number of areas reporting anthrax increased from two administrative areas per year to a maximum of nine administrative areas. The population was mainly middle-aged, and there were more males than females.

Conclusion: In Chifeng, Inner Mongolia, China, the administrative areas where anthrax cases were reported were concentrated in agricultural-pastoral region, and the number of reporting administrative areas showed an increasing trend year by year. There was no clear periodicity in the epidemic of anthrax cases, but there was distinct seasonal patterns. Most of the cases were middle-aged male farmers and herdsmen.

Keywords : China, Inner Mongolia Autonomous Region, Chifeng, Anthrax, Epidemiological characteristics.

INTRODUCTION

Inner Mongolia Autonomous Region is located in the northern border of China, extending from northeast to southwest, with a length of about 2,400 kilometers from east to west and a maximum span of more than 1,700 kilometers from north to south, with a total area of 1.183 million square kilometers. It is the third largest province in China, with diverse geographical landforms such as grasslands, forests, rivers and chernozem soils, and is an important production base for beef, mutton and dairy products in China[1]. Chifeng is a prefectural-level city of Inner Mongolia Autonomous Region, located in the southeast of the Inner Mongolia Autonomous Region. With a total area of 90,000 square kilometers and 12 administrative regions, Chifeng is the most populous city in Inner Mongolia Autonomous Region, with a population of about 4 million. It is mainly based on agricultural and pastoral areas, and the breeding industry is relatively developed, mainly breeding cattle and sheep[2].

Anthrax is a zoonotic infectious disease caused by Bacillus anthracis[3]. B.anthracis spores persist in the natural environment and can survive for decades in soil[4]. It can infect almost all poultry and domestic animals, among which herbivores such as cattle, horses and sheep are most

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Received: 10-June-2025, Manuscript No. JOID-4927 **; Editor Assigned:** 11-June-2025 **; Reviewed:** 30-June-2025, QC No. JOID-4927 **; Published:** 11-July-2025, **DOI:** 10.52338/joid.2025.4927.
Citation: Xiao Ji,MD. Epidemiological Characteristics of Anthrax in an Agricultural-pastoral Region of Northeastern China: a 21-year Cross-sectional Study. Journal of Infectious Diseases. 2025 July; 12(1). doi: 10.52338/joid.2025.4927.
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susceptible to infection[5]. When residents engage in production and life behaviors such as livestock grazing, slaughtering and trading, they have the opportunity to contact with diseased livestock and be infected with Bacillus anthracis[6]. Cutaneous anthrax is the most common type of infected people[7], and they are infected mainly through contact with meat, viscera and fur of anthrax infected livestock[8].

Anthrax is a global disease. The incidence of anthrax has been reduced by continuous research and disease control measures, but it still occurs in undeveloped and developing countries[9]. Chifeng City, as a farming and animal husbandry city, provides the conditions for the occurrence of anthrax. The number of reported cases from 2008 to 2017 was the second in Inner Mongolia Autonomous Region[10]. The area of anthrax in Chifeng is wide, covering all agricultural and pastoral areas. Therefore, understanding the epidemic characteristics of anthrax in Chifeng and further controlling the occurrence of anthrax epidemic are particularly important to protect the life and health of the residents and food safety.

METHOD

Data

China Information System for Disease Control and Prevention[11]: China Information System for Disease Control and Prevention is a national information system built by the Chinese Center for Disease Control and Prevention for medical and health users. The system focuses on the reporting of infectious diseases and public health emergencies. At present, it has covered all medical and health institutions in the country.

Center for Disease Control and Prevention[12]: It is a public welfare institution organized by the government to implement the technical management and service of disease prevention and control and public health. Its main responsibilities include disease prevention and control, emergency response to public health emergencies, monitoring and intervention of health hazards, laboratory testing and evaluation, health education and health promotion, etc.

Data reporting criteria[13]: Medical institutions diagnosed anthrax cases in accordance with the diagnostic criteria of anthrax in the Health industry Standard of the People's Republic of China (WS 283-2020), and reported them directly through the China Disease Prevention and Control Information System according to the types of suspected cases, clinically diagnosed cases and confirmed cases in the diagnostic criteria. The anthrax case information reported by medical institutions will be reviewed by the Center for Disease Control and Prevention in the China Disease Prevention and Control Information System, and the anthrax case information will be the final reported information. The users of the China Disease Prevention and Control information System must pass the approval of the unit, training, and user record, and issue a digital certificate to have the qualification to log in to the China disease prevention and control information system. Medical institutions and centers for disease control and prevention must pass their own digital certificate to log in to the system to ensure the data integrity and security.

Statistical Analysis

The data of 145 anthrax cases reported by 354 medical institutions in Chifeng from 2004 to 2024 were collected from the China Information System for Disease Control and Prevention. Microsoft Office Excel 2019 was used to establish a database.

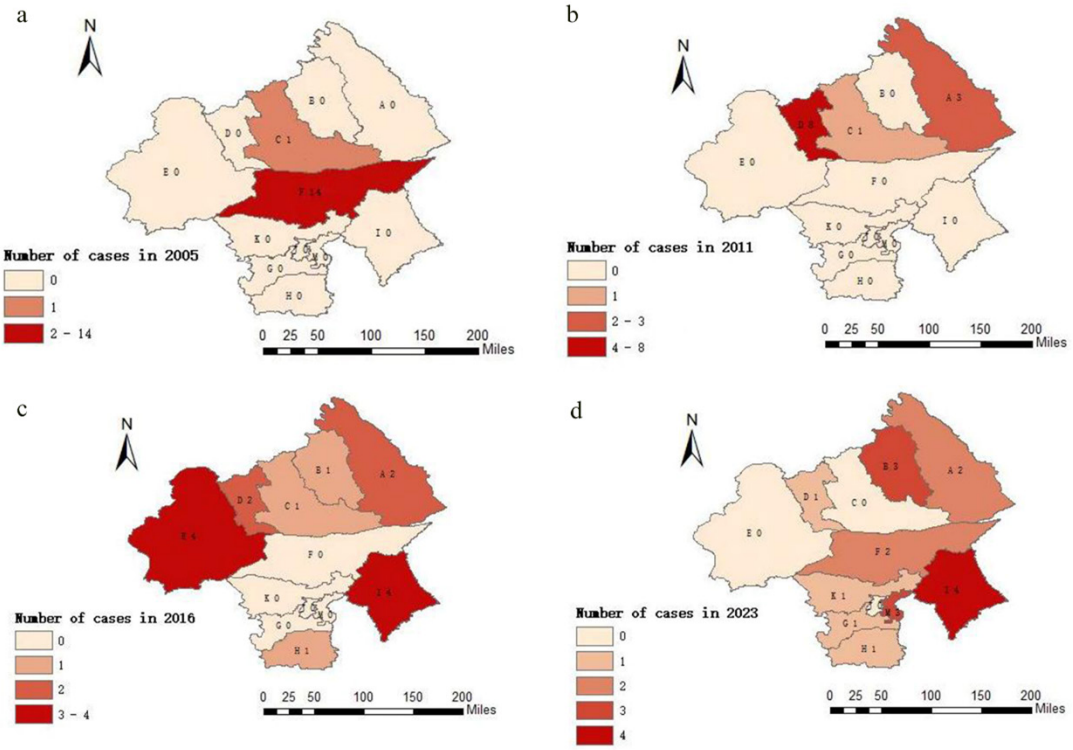
Descriptive statistics included frequency analyses for categorical variables and means for continuous variables. Chi-square tests were used to calculate differences in categorical variables. Statistical Product and Service Solutions 26.0 software was used for statistical analysis, and $P < 0.05$ was considered statistically significant. ArcGIS version 10.0 was used to map the regional distribution of cases.

RESULTS

Regional characteristics

From 2004 to 2024, anthrax cases were reported in 11 of 12 administrative areas in Chifeng. There were 26 cases in region A, 26 cases in region F and 21 cases in region D, accounting for 50.34% of the total cases, followed by 15 cases in region I, 15 cases in region E, 15 cases in region M, 8 cases in region K, 7 cases in region G, 6 cases in region C, 4 cases in region B, 2 cases in region H, and no cases in region J. In the peak reporting years, cases were reported in 2 administrative areas in 2005, 3 in 2011, 7 in 2016, and 9 in 2023, with darker colors indicating greater numbers of cases (**Figure 1**).

Figure 1. Regional changes of anthrax case reporting in Chifeng City in 2005, 2011, 2016, and 2023



In terms of regional distribution, there were significant differences in the number of cases in different regions ($\chi 2$=145.61, P <0.001) (**Table 1**).

Population characteristics

In terms of age and sex distribution, there were 111 male cases (76.55%) and 34 female cases (23.45%), and the ratio of male to female cases was 3.26:1. The average age of males was 48.06±14.33 years old, and the youngest was 14 years old, and the oldest was 76 years old. The average age of females was 50.21±12.96 years old, with the youngest age 13 years old and the oldest age 75 years old. The age of anthrax cases in Chifeng City was mainly between 45 and 64 years old, with 72 cases, accounting for 49.66% of the total cases. In terms of occupational distribution, the cases were mainly farmers, herdsmen, workers, retired personnel, homemaker and unemployed, and students. Farmers and herdsmen were the main population, with 118 cases reported by farmers, accounting for 81.38% of the total cases, and 17 cases reported by herdsmen, accounting for 11.72% of the total cases. (**Table 1**)

The incidence of male was significantly higher than that of female ($\chi 2$=36.81, OR=3.13, 95%CI[2.13-4.60], *P* <0.001). There was a significant difference in the distribution of the number of cases in different age groups ($\chi 2$=39.88, *P* <0.001), indicating that both gender and age had a significant effect on the incidence (**Table 1**).

Table 1. Epidemiological Characteristics of Anthrax Cases in Chifeng from 2004 to 2024

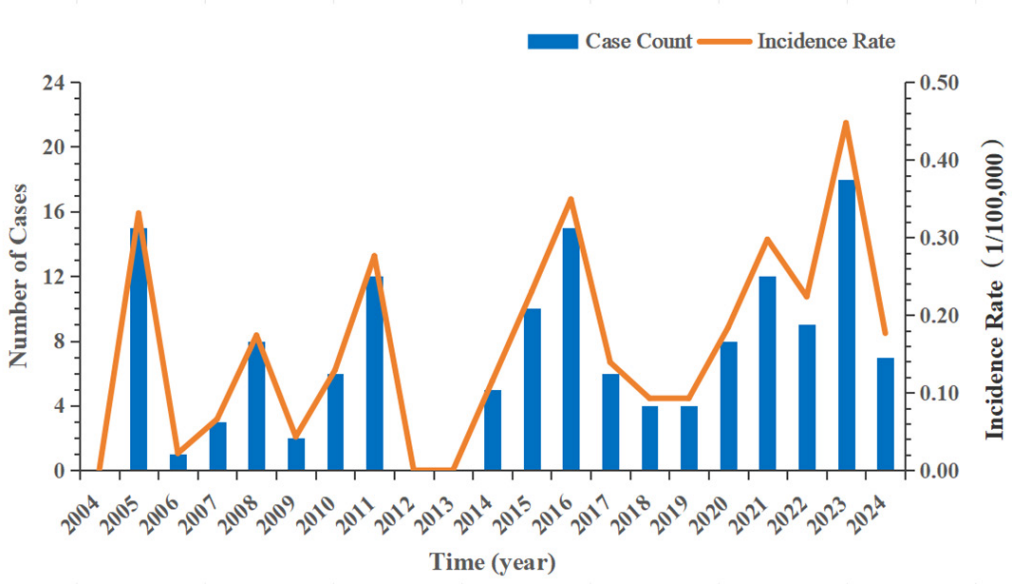
	Reported cases	Proportion (%)	χ2	P
Region			145.61	<0.001
A Region	26	17.93		
B Region	4	2.76		
C Region	6	4.14		
D Region	21	14.48		
E Region	15	10.34		
F Region	26	17.93		
G Region	7	4.83		
H Region	2	1.38		
I Region	15	10.34		
J Region	0	0.00		

K Region	8	5.52		
M Region	15	10.34		
Gender			36.81	<0.001
Male	111	76.55		
Female	34	23.45		
Age			39.88	<0.001
0-14	3	2.07		
15-19	1	0.69		
20-24	2	1.38		
25-29	8	5.52		
30-34	14	9.66		
35-39	12	8.28		
40-44	14	9.66		
45-49	17	11.72		
50-54	21	14.48		
55-59	16	11.03		
60-64	18	12.41		
65-69	11	7.59		
70-74	6	4.14		
75-79	2	1.38		
>80	0	0.00		
Occupations			-	-
Student	2	1.38		
Homemaker/unemployed	2	1.38		
Retired persons	2	1.38		
Workers	4	2.76		
Herdsmen	17	11.72		
Farmer	118	81.38		

Characteristics of time distribution

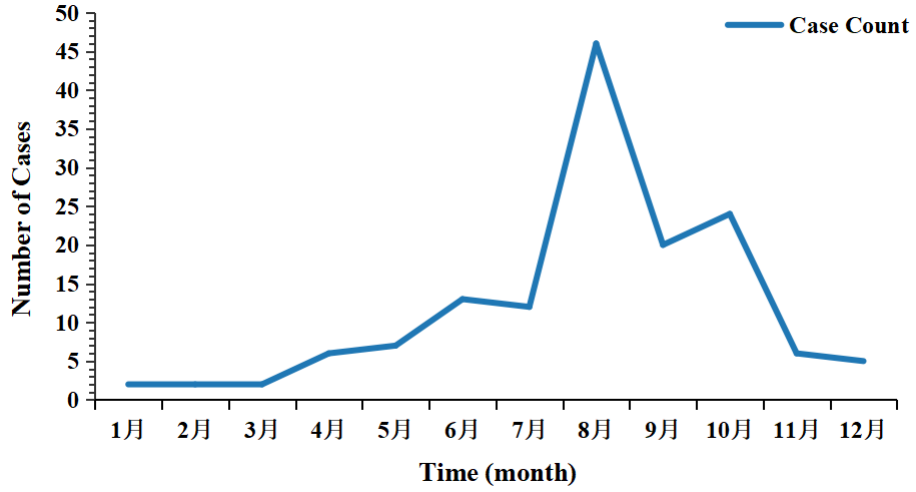
From 2004 to 2024, a total of 145 cases of human anthrax were reported in Chifeng. All the 145 cases were cutaneous anthrax, and 2 of them were complicated with intestinal anthrax. The average annual incidence was 0.16/100 000. Two patients died, with a mortality rate of 1.38%. Peaks in incidence occurred in 2005, 2011, 2016, and 2023 (**Figure 2**).

Figure 2. Trend of anthrax cases in Chifeng from 2004 to 2024



During the 21 years, 115 anthrax cases were concentrated from June to October, accounting for 79.31% of the total number of cases. The epidemic peak occurred in August (**Figure 3**).

Figure 3. Anthrax cases in Chifeng City in different months from 2004 to 2024.



During the 21 years, the peaks of anthrax cases reported in Chifeng were 2005, 2011, 2016, and 2023. According to the cause of the incidence peak, the reported areas involved 2 and 3 administrative areas in 2005 and 2011, respectively, and clusters of COVID-19 occurred in both areas. In 2016 and 2023, the reporting areas involved 7 and 9 administrative areas, respectively, and all cases were sporadic. Therefore, the peak of anthrax incidence in City was related to the occurrence of clusters and the number of areas, but not to the time. There was no periodicity.

DISCUSSION

In recent years, the number of anthrax reporting areas in Chifeng has been increasing year by year, which likely attributable to Chifeng is an agricultural and animal husbandry area, and aquaculture is the main pillar industry. With the increasingly convenient transportation and frequent livestock trading, long-distance transportation is easier to achieve, and new areas are contaminated by livestock carrying Bacillus anthracis due to livestock trading[14]. It is also possible that Bacillus anthracis may be washed out of deep soil due to the coming flood in the rainy season[15], which increases the risk of infection of livestock in the process of grazing, and then increases the risk of human anthrax. The reported areas are mainly agricultural and pastoral areas, and there are no reports in urban areas, which may be related to the breeding industry. The incidence of anthrax is mainly transmitted by direct contact with sick and dead livestock [16], and the risk of anthrax is low when buying and eating livestock meat products.

The proportion of infected males was higher than that of females, which was consistent with the data from Heilongjiang and Henan provinces of China and with the epidemiological characteristics of the United States[8, 17,18,]. The main reason is that males are the main labor force in the family[8], and mainly males participate in the slaughter of livestock, so the exposure risk is relatively high. Different from other areas, because the young labor force in Chifeng is generally migrant workers, the majority of people engaged in aquaculture in farming and animal husbandry areas are middle-aged. This is also an important factor leading to the fact that most anthrax cases in this area are middle-aged people. The main causes of the disease in women and people of lower age groups might be the poor health conditions in farming and animal husbandry areas, the lack of awareness of human protection, and the direct contact with raw meat or cross infection of raw and cooked livestock during the slaughter of sick and dead livestock within the family. All cases of anthrax were cutaneous anthrax, which may be related to the easy implementation of skin contact infection in the transmission route of anthrax. Residents generally had no protective measures when slaughtering and dividing livestock, so the exposed skin in the process of working would directly contact the dead livestock. In Chifeng, there is no daily habit of consuming raw meat. All the meat consumed was cooked meat, but there was crossover between raw and cooked meat. The 2 cases combined with intestinal anthrax may be infected by this situation.

There were four anthrax epidemic peaks in the past 21 years. In 2005 and 2011, a cluster of anthrax outbreaks occurred in area F and area D, respectively. Different from the characteristics of the epidemics in 2005 and 2011, there was no cluster of epidemics in 2016 and 2023, and the epidemic was mainly sporadic, but the number of cases was large because the areas involved were more. With the increase of epidemic focus, the possibility of anthrax epidemic in Chifeng City was higher in recent years. According to the

occurrence months of anthrax, it mainly occurred from August to October, which was consistent with the epidemic characteristics of anthrax in Inner Mongolia[10]. Our results are consistent with the results of another team, which showed that anthrax cases mostly occurred in summer and autumn in China from 2017 to 2019, with a peak in August[19]. The hot and rainy seasonal characteristics facilitate the survival and spread of anthrax spores [20]. This period of time into the local slaughter season increases the opportunity for population exposure. Previous studies have shown that blood-sucking flies can ingests anthrax spores through carcasses or blood of anthrax animals, and the spores proliferate in the intestine and are excreted, thereby contaminating the environment and grass, leading to anthrax infection in animals[21].

In conclusion, as an important infectious disease in Chifeng, it is very important to understand the epidemiological characteristics of anthrax for the prevention and control of anthrax. The first suggestion is to timely detect and handle the animal epidemic to prevent the spread of the animal epidemic to humans. Therefore, strengthening the surveillance of animal epidemic is the key to prevent the occurrence of anthrax cases[22]. The second is to prevent the further expansion of the epidemic focus, timely and harmless disposal of sick and dead livestock, terminal disinfection of sick and dead livestock and places contaminated by cases, standardized livestock trading, prevent sick (dead) livestock from entering the market, and preventive disinfection of key places in the epidemic season. The third is to strengthen the management of key groups, master the livestock breeding, fur processing, slaughtering and other key groups in the jurisdiction, carry out key publicity and intervention, teach health protection skills, and reduce the exposure risk of the population.

Competing Interest

The authors declare that the research was conducted in the any commercial or financial relationships that could be construed as a potential conflict of interest.

Data Availability

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Acknowledgement

NA.

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