

## Epidemiological Characteristics of Human Anthrax — China, 2018–2021

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### ABSTRACT

**Introduction:** The epidemic of human anthrax is at a low level in China in recent years, but the reported incidence increased in 2021. In order to understand the current landscape of research and knowledge about anthrax in China, the epidemiological characteristics of anthrax in humans from 2018 to 2021 were analyzed and the prevention and control suggestions were proposed.

**Methods:** Surveillance data of anthrax in humans and livestock, together with human outbreaks data during 2018–2021, were collected and analyzed by descriptive statistics methods. The number and proportion of outbreaks, cases and deaths by provincial-level administrative divisions (PLADs), clinical types, and contributing factors were calculated.

**Results:** A total of 1,244 cases of human anthrax and 53 outbreaks were reported from 2018 to 2021 in China. While the incidence of anthrax declined from 2018 to 2020, it increased in 2021. The regions of anthrax were mainly located in the west and the northeast PLADs of China, though cases were reported in some central and eastern PLADs in 2021. Young and middle-aged men involved in animal husbandry were found to be at a higher risk of anthrax. All the reported outbreaks were associated with the exposure of infected livestock. A total of 296 livestock anthrax cases were reported.

**Conclusions:** The increased incidence and wider geographical distribution of human anthrax in 2021 were found to be the result of inadequate supervision of diseased animals as well as updated diagnostic criteria. As such, the monitoring of risk factors and emergency preparation procedures should be strengthened at the national level. In addition, it is also critical to strengthen health education for high-risk occupational groups and strengthen professional training for local clinicians. Finally, more measures should be carried out to strengthen anthrax surveillance in livestock husbandry.

Anthrax is an acute, infectious, zoonotic disease caused by *Bacillus anthracis* (*B. anthracis*) that can form spores, is resistant to extreme environmental conditions, and can persist for long periods of time in soil or hay. Anthrax mostly infects susceptible herbivores, such as cattle, mules, sheep, horses, and donkeys. Humans become infected through contact with diseased animals or by inhaling spores from contaminated animal products accidentally (1). The emergence of injectional anthrax among heroin users in Europe highlights the possibility of new routes of the spread of human anthrax (2). In addition, *B. anthracis* can be used as a biological weapon, and several anthrax-related bioterrorism events have occurred — resulting in intentional outbreaks (2).

Anthrax is still prevalent in many countries in Asia and Africa, as well as in some countries in Europe and America (3). In China, the national anthrax surveillance project has been gradually scaled up since 2005; alongside this, the number of human anthrax cases has gradually decreased over the last three decades, though a few comparatively larger anthrax outbreaks still occurred (4–6). Currently, anthrax remains a threatening endemic disease in China, and a considerable number of human anthrax cases are reported every year (7). In 2021, human anthrax outbreaks were reported in more than 20 counties in China, some of which belonged to historically low-incidence areas (8), and some of which happened in places where no anthrax cases had been reported for many years. In order to understand the current knowledge of anthrax in China, the national epidemiological surveillance data of anthrax in humans and livestock from 2018 to 2021 were analyzed. Sourced from this analysis, corresponding risk factors were identified and recommended policy measures are outlined at the conclusion.

### METHODS

The reported cases and outbreaks of anthrax in

humans were collected from the China Information System for Disease Control and Prevention. All clinically-diagnosed cases and laboratory-confirmed cases during 2018–2021 were included in this study. These cases were identified according to the anthrax case definitions issued by the National Health Commission of the People's Republic of China. It should be noted that, before November 2020, human anthrax cases were identified according to the *Diagnostic Criteria for Anthrax* (WS 283–2008). After November 2020, the diagnostic criteria for anthrax were updated in China, so the human anthrax cases after November 2020 were diagnosed according to the new diagnostic criteria (WS 283–2020) (9). In addition to previous methods, polymerase chain reaction methods for specific genes of *B. anthracis*, the detection of antibodies or antigens of *B. anthracis*, as well as documented anthrax environmental exposure were included in the new criteria.

The definition of an anthrax outbreak in this research is based on the following standards: the case(s) in a potential outbreak either needed to involve an inhalational or fur processing related anthrax case or more than 3 cutaneous or gastrointestinal anthrax cases in a week in a limited area (e.g., in a village, a school, etc.). Such an anthrax outbreak was required to be reported as an anthrax public health event. Since 2021, one of the items about anthrax outbreaks was added,

i.e. when a cutaneous or gastrointestinal anthrax case was found in a county or in a district where no cases were reported over the past 5 years, it was also considered as an anthrax outbreak and required to be reported.

Routine surveillance of livestock anthrax is organized by the Ministry of Agriculture and Rural Affairs of the People's Republic of China and corresponding data are published monthly on the Official Veterinary Bulletin (10).

## RESULTS

A total of 1,244 human anthrax cases with 7 deaths were reported in China from 2018 to 2021, with 336 reported in 2018, 297 in 2019, 224 in 2020, and 387 in 2021. These cases were distributed across 19 provincial-level administrative divisions (PLADs) in China. The majority of cases (76.8%, or 955/1,244 cases) were located in western and northeastern China, such as Sichuan Province, Gansu Province, Qinghai Province, Inner Mongolia Autonomous Region, and Xinjiang Uygur Autonomous Region. Notably, the 51 total cases in 2021 were sourced from Shandong Province (22 cases), Anhui Province (8 cases), and Shanxi Province (21 cases). This was significant because there were no human anthrax cases reported in these 3 provinces in the past 5 years — save for 1 case

TABLE 1. General characteristics of reported cases of human anthrax in China, 2018–2021.

Variable	2018		2019		2020		2021		Total	
	Number of cases	Proportion (%)	Number of cases	Proportion (%)	Number of cases	Proportion (%)	Number of cases	Proportion (%)	Number of cases	Proportion (%)
Total	336	100.0	297	100.0	224	100.0	387	100.0	1,244	100.0
Age (years)										
0–24	39	11.6	36	12.1	18	8.0	33	8.5	126	10.1
25–49	213	63.4	180	60.6	124	55.4	219	56.6	736	59.2
50–	84	25.0	81	27.3	82	36.6	135	34.9	382	30.7
Sex										
Male	248	73.8	232	78.1	139	62.1	295	76.2	914	73.5
Female	88	26.2	65	21.9	85	37.9	92	23.8	330	26.5
Occupation										
Herdsmen	167	49.7	156	52.5	129	57.6	177	45.7	629	50.6
Farmers	121	36.0	109	36.7	79	35.3	167	43.2	476	38.3
Others	48	14.3	32	10.8	16	7.1	43	11.1	139	11.2
Clinical type										
Cutaneous	331	98.5	290	97.6	221	98.7	382	98.7	1,224	98.4
Inhalational	0	0.0	0	0.0	1	0.4	1	0.3	2	0.2
Others	5	1.5	7	2.4	2	0.9	4	1.0	18	1.4

being reported in Shanxi in 2020. The characteristics of the cases are listed in Table 1. The proportion of cases in persons aged 25–49 years old was 59.2%. About 73.5% of cases were in men. About 50.6% of cases were herdsmen and 38.3% of cases were farmers. In terms of the clinical types of cases, 98.4% of the cases were cutaneous anthrax, with 4 deaths and a fatality rate of 0.3% (4/1,224); two cases were inhalational anthrax with no deaths; and about 1.4% of the cases (18 cases) belonged to other clinical types, including intestinal anthrax, septicemia, and meningitis anthrax, with 3 deaths and a fatality rate of 16.7% (3/18). Figure 1 shows the monthly reported cases of anthrax in humans and livestock in China from 2018 to 2021. Human anthrax cases occurred throughout the year, and peaked around July or August. A total of 296 livestock anthrax cases were reported: 77.4% (229/296) of which originated from cattle.

There were a total of 53 human anthrax outbreaks involving 224 cases reported from 2018 to 2021. The year with the fewest was 2020 (4 outbreaks), while the year with the most was 2021 (24 outbreaks) (Table 2). These outbreaks occurred from July to September, with a peak in August. The epidemiological

investigation revealed that the majority of these outbreaks were sourced from being exposed to livestock anthrax as a result of slaughtering, skinning, or eating poorly-cooked, contaminated meat. Notably, before 2021, anthrax outbreaks mainly occurred in areas that historically suffered from epidemic anthrax in China, such as Inner Mongolia, Gansu, and Sichuan PLADs. However, in 2021, some provinces with lower historical anthrax incidence reported anthrax outbreaks, including 2 outbreaks in Anhui, 1 outbreak in Shanxi, and 8 outbreaks in Shandong. One outbreak in Shandong Province even involved the death of a 14-year-old student (meningitis anthrax), which aroused great public concern at that time. Because inhalational anthrax is defined as a public health event and is required to be managed as a class A infectious disease in China, more public concern is also aroused by an inhalational anthrax case in Beijing in 2021. In fact, this was the second inhalational anthrax case to have sought treatment in Beijing recently: the former occurred in 2020. Another noteworthy issue is that anthrax outbreaks occurred in 3 consecutive years (2019, 2020, and 2021) in Henan Province, while it had been 16 years before 2019 without reported cases. In addition, some special clinical types of anthrax have

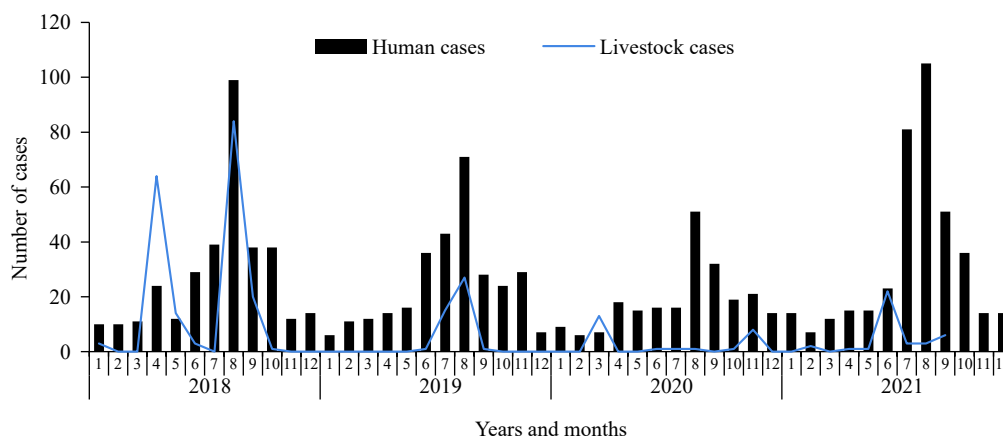


FIGURE 1. The monthly reported cases of anthrax in humans and livestock in China, 2018–2021.

TABLE 2. Reported human anthrax outbreaks, PLADs and cases involved in China, 2018–2021.

Year	Number of outbreaks (n)	Involved PLADs (n)	Involved cases (n)
2018	11	8	60
2019	14	9	57
2020	4	4	12
2021	24	11	95
Total	53	16	224

Abbreviation: PLADs=provincial-level administrative divisions.

occurred in recent years, such as one intestinal anthrax outbreak in Sichuan in 2018, inhalational anthrax in Hebei in 2020 and 2021, and meningitis and septicemia anthrax in Shandong in 2021.

## CONCLUSIONS

Generally, human anthrax epidemics in China have showed a steadily decreasing trend over the past three decades, with occasional small-scale rebounds in certain years (7). This study shows that the reported incidence of human anthrax in China decreased year by year from 2018 to 2020, but increased in 2021, with an increase of 35.3 percent compared to the average incidence of the previous three years. At present, the annual reporting numbers are less than 400 in China, which is a low incidence level. West and northeast China are the highest-risk areas for human anthrax. However, corresponding risks in the central and eastern regions of China increased in 2021. The young and middle-aged men engaged in agriculture and animal husbandry in the western and northeastern regions are at risk of anthrax, and should be monitored and trained. Meanwhile, monitoring of outbreaks and risk factors in other regions of China should be strengthened.

Human cases of anthrax usually result from contact with infected livestock during the slaughtering, butchering, and skinning processes. Nevertheless, this study found the number of reported livestock anthrax cases was comparatively much lower than human anthrax in China, which indicates that anthrax surveillance and reporting in livestock husbandry is inadequate. Regular livestock supervision is the fundamental way to control the transmission of anthrax in humans. Vaccination of livestock, more effective quarantine and inspection measures for livestock, and harmless disposal of dead livestock in affected areas are very essential. As a public health response, offering some joint approaches between livestock and human countermeasures could contribute to controlling anthrax outbreaks in the future.

In general, some noteworthy features of human anthrax occurred in 2021, including a greater number of reported cases, wider geographical spread, and more diversity of clinical types. One reason for these features may be the update of diagnostic criteria for human anthrax cases, which could contribute to the incomparability of the data to some extent. On the other hand, a relatively truer picture of anthrax epidemics was revealed due to the new diagnostic

criteria. The high-sensitivity gene testing in new criteria can improve positive detection in clinical samples. More laboratory assays and evidence promote more human anthrax cases to obtain laboratory diagnostic support and increase the number of laboratory-confirmed anthrax cases. Another reason for the unusual features of anthrax cases in 2021 may be ongoing personnel training in anthrax diagnostic capacity, along with gradual improvement in public awareness about anthrax prevention and control, and more patients seeing doctors in time — which allows doctors to make diagnoses more quickly and correctly. These efforts contributed to early detection and treatment of cases. However, it is still necessary to continue strengthening training in this area, because this study found that the higher fatality rate of other clinical types, excepting cutaneous anthrax, may be related to delays in seeking medical attention, as well as to the special pathogenesis. Therefore, further studies on the etiology and treatment of varying clinical types should be strengthened in the future.

This study was subject to some limitations. First, the update of diagnostic criteria for human anthrax cases affected the comparability of the data. Second, this study did not investigate molecular epidemiological characteristics, which needs to be carried out in the future. Third, the development of livestock husbandry influences the incidence of human anthrax, but this study did not acquire general information on livestock breeding, transportation, vaccination, quarantine, etc.

In conclusion, this study's results showed that the epidemic of human anthrax was at a low level in China, but the increased incidence and the wider geographical distribution in 2021 suggest that the monitoring of risk factors and emergency preparation procedures should be strengthened at the national level. Most cases were farmers, shepherds, and employees in the slaughtering industry, so health education for them is still an important way to prevent anthrax. In addition, professional training for local clinicians should be strengthened to enable them to recognize and identify various clinical anthrax cases earlier. On the other hand, anthrax surveillance and reporting in livestock husbandry were inadequate; as such, more measures and policies should be carried out to strengthen the monitoring of anthrax in livestock husbandry.

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