Preplanned Studies

Plague Risk Assessment — China, 2022

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Summary

What is already known about this topic?

China has the largest and most complex natural reservoir of plague in the world. Since the 1980s, our country standardized animal plague surveillance and accumulated a substantial amount of useful epidemiological data. In accordance with the "Criteria for Determining Plague Natural Foci and Plague Epizootics (GB 16883–1997)," Ya Dong, Xizang (Tibet) was identified as a new plague focus in 2021 (*Marmota himalayana* plague).

What is added by this report?

Based on plague epidemiology in the past 20 years, we identify high-risk areas in 2022 to provide scientific evidence supporting plague prevention and control policy in China.

What are the implications for public health practice?

To avoid the spread of plague to humans, we recommend strengthening animal plague monitoring in high-risk and adjacent areas and timely investigation and response to animal plague epidemics. Early detection, early reporting, early diagnosis, early isolation, and early treatment of human plague helps prevent spread and long-distance transmission of plague.

Plague is an acute and severe infectious disease that is usually found in rodents but can spread to humans and seriously impact health and socio-economic development (*1*). By the end of 2021, there were 12 types of natural plague foci in the mainland of China, located in 322 county-level divisions of 19 provincial-level administrative divisions (PLADs), covering a total of 1,587,666.67 square kilometers. In 2021, one non-fatal case of human plague occurred in China.

Primary level prevention measures, including active surveillance and periodic epizootic plague risk assessments, are known effective methods to prevent the spread of plague from animals to humans. Based on the epidemiological situation of plague in the past 20 years in China, we identify high-risk areas in 2022 to provide support for domestic plague prevention and control policy.

We used risk matrix and Borda count methods to conduct a risk assessment of plague foci in China based on the frequency of human plague epidemics and plague epizootics and other relevant factors — plague foci, etiology, transmission characteristics, and hygiene practices (*2*–*3*). The data used in our analyses are from the "Information System for Plague Prevention and Control" and annual surveillance reports from PLADs.

Plague epizootics or positive indications were found for 5 types of natural plague foci (*Marmota himalayana* in Qinghai-Tibet Plateau, *Meriones unguiculatus* in Inner Mongolia Plateau, *Marmota baibacina-Spermophilus undulatus* in Tianshan Mountains, *Microtus fuscus* in Qinghai-Tibet Plateau, *Rhombomys opimus* in Junggar Basin), located in 33 county-level divisions of 7 PLADs and 1 regiment farm of Xinjiang Production and Construction Corps. Xinjiang Uygur Autonomous Region had 9 country-level foci: Xizang (Tibet) Autonomous Region had 8; Inner Mongolia Autonomous Region had 7; Gansu Province had 5; Sichuan Province had 2; and Qinghai Province and Ningxia Hui Autonomous Region each had 1.

From 2002 to 2021, plague epizootics or positive indications were found for 12 types of natural plague foci in 196 county-level divisions of 16 PLADs. In terms of plague foci, there were 458 occurrences of *Marmota himalayana* plague in 85 counties, 60 occurrences of *Rattus flavipectus* plague in 29 counties, 134 occurrences of *Meriones unguiculatus* plague in 23 counties, 104 occurrences of *Rhombomys opimus* plague in 16 counties, 109 occurrences of *Marmota baibacina-Spermophilus undulatus* plague in 12 counties, 30 occurrences of *Spermophilus dauricus* plague in 12 counties, 20 occurrences of *Apodemus chevrieri-Eothenomys milrtus* plague in 6 counties, 14 occurrences of *Microtus brandti* plague in 4 counties, 15 occurrences of *Marmota sibirica* plague in 3 counties, 7 occurrences of *Marmota caudata* plague in 3 counties, 3 occurrences of *Spermophilus alaschanicus*

plague in 2 counties, and 20 occurrences of *Microtus fuscus* in 1 county.

There were 244 occurrences in 49 counties of Xizang (Tibet) Autonomous Region; 234 occurrences in 35 counties of Xinjiang Uygur Autonomous Region; 177 occurrences in 34 counties of Inner Mongolia Autonomous Region; 59 occurrences in 26 counties of Yunnan Province; 80 occurrences in 19 counties of Qinghai Province; 56 occurrences in 10 counties of Sichuan Province; 88 occurrences in 6 counties of Gansu Province; 10 occurrences in 6 counties of Ningxia Hui Autonomous Region; 8 occurrences in 3 counties of Zhejiang Province; 4 occurrences in 2 counties of Guangxi Zhuang Autonomous; 5 occurrences in 1 county of Hebei Province; 4 occurrences in 1 county of Guizhou Province; 1 occurrence in 1 county of Shaanxi Province; and 1 occurrence in 1 county each in Jilin, Liaoning, and Hunan provinces.

In terms of frequency of plague epizootics, 5 counties (2 in Gansu, 2 in Xinjiang, and 1 in Sichuan) experienced plague epizootics every year, 23 counties [7 in Xinjiang, 6 in Xizang (Tibet), 5 in Inner Mongolia, 3 in Gansu, and 2 in Qinghai] experienced plague epizootics between 10 and 19 times during the past 20 years; 55 counties [18 in Xizang (Tibet); 13 in Inner Mongolia; 11 in Xinjiang; 4 in each of Sichuan, Yunnan, and Qinghai; and 1 in Hebei] experienced plague epizootics between 5 and 9 times during the past 20 years; 113 counties experienced plague epizootics in fewer than 5 times during the past 20 years.

Based on the occurrence of human plague and plague epizootics in recent years and a comprehensive analysis of plague foci, etiology, transmission characteristics and other factors, the possibility of human plague in 2022 cannot be ruled out. The high-risk months for 2022 will be July to October, the medium-risk months are May, June and November, and other months are low-risk months.

The relative weights of significant risk factors of plague outbreaks (e.g. frequency, quiescent years of plague epizootics) were scored in consultation with experts (*4*). Risk probability ranking and risk impact ranking of 196 counties that had plague foci in the past 20 years were calculated and their Borda points were tallied [Borda=(196–Risk probability ranking)+(196–risk impact ranking)]. Overall, 30 county-level divisions with the highest risk were identified according to Borda point tallies and in consultation with experts (Table 1).

DISCUSSION

An occurrence of human plague has significant negative impact on an affected population and causes serious damage to normal life in the area (*5*). Strong emergency control measures requiring large amounts of resources are then needed to mitigate negative impact and damage.

Human plague risk assessment is based on several factors, such as plague epizootics characteristics, ground time of host animals, contact between host animals and human beings, and the virulence of *Yersinia pestis*. Risk assessments are sensitive to several related factors. For example, environmental factors of precipitation, temperature, vegetation, and land use indirectly affect the occurrence of human plague by influencing the survival and reproduction of animals and insects (*6*). Social factors, including healthcare and sanitary conditions, living standards, educational level, and religious beliefs and customs contribute to the occurrence and spread of human plague by increasing exposure to infected animals. When there is an outbreak of human plague abroad, the risk in China increases. Illegal hunting of infected animals in plague foci and long-distance transportation of prey increases the risk of human plague in other areas. Patients seeking medical treatment in other cities increases the risk of bringing plague into large and medium-sized cities. There is a risk of transmission from secondary hosts, that is, infection transmitted by contact with an infected host animal during its hibernation period in a plague foci. Natural disasters and large-scale engineering projects can lead to abnormal gathering of host animals, thus increasing the risk of human infection (*7*).

We identified 30 county-level divisions at high risk of human plague. However, unlisted divisions in our analyses are not risk-free but rather have a relatively lower risk. PLADs should take plague prevention and control measures in high-risk counties, cities, districts, and adjacent areas to prevent the spread of plague from animals to humans (*8*). At the beginning of each year, or during plague-prone seasons, PLADs should routinely conduct plague risk assessments and take timely and effective interventions in the plague foci areas based on risk assessment results.

TABLE 1. High-risk counties of human plague in China, 2022.

PLADs	County	Epidemic frequency	Number of quiescent years	Risk probability	Risk impact	Borda points	Rank
Inner Mongolia	Siziwang	15	20	8	8	348	1
Inner Mongolia	Erlianho	16	20	10	36	346	2
Inner Mongolia	Huade	12	20	13	36	343	3
Inner Mongolia	OtogBanner	10	20	15	36	341	4
Yunnan	Menghai	5	19	54	1	337	5
Gansu	Subei	20	20	1	59	332	6
Inner Mongolia	Otog Front Banner	9	20	24	36	332	6
Gansu	Aksay	20	20	2	59	331	8
Gansu	Yumen	19	20	5	59	328	9
Yunnan	Yulong	9	17	35	30	327	10
Gansu	Sunan	18	20	7	59	326	11
Xizang (Tibet)	Linzhou	17	20	9	59	324	12
Qinghai	Wulan	18	19	12	59	321	13
Xizang (Tibet)	Dangxiong	15	20	15	59	318	14
Xizang (Tibet)	Gar	14	19	17	59	316	15
Yunnan	Gucheng	5	19	48	30	314	16
Inner Mongolia	Wuchuan	3	20	43	36	313	17
Xizang (Tibet)	Jiangzi	8	20	22	59	311	18
Sichuan	Batang	9	19	25	59	308	19
Sichuan	Yajiang	5	20	33	59	300	20
Qinghai	Tianjun	6	19	35	59	298	21
Sichuan	Litang	6	19	35	59	298	21
Hebei	Kangbao	5	17	69	36	287	23
Qinghai	Dulan	2	20	61	59	272	24
Qinghai	Qilian	5	16	61	59	272	24
Xizang (Tibet)	Yadong	1	20	61	59	272	24
Yunnan	Jianchuan	1	16	96	30	266	27
Xinjiang	Midong	12	20	14	156	222	28
Xinjiang	Wusu	20	20	3	177	212	29
Xinjiang	Jinghe	20	20	5	177	210	30

Abbreviations: PLADs=provincial-level administrative divisions.

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