Preplanned Studies

Serological Prevalence Survey Among the High-Risk Populations of Brucellosis-Endemic Areas — China, 2019–2020

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Summary

What is already known about this topic?

Timely screening of high-risk population is important to improve the early detection of brucellosis among the endemic areas during the high incidence seasons, which is also required by the National Brucellosis Prevention and Control Plan (2016–2020) (NBPCP).

What is added by this report?

Seroepidemiological characteristics of brucellosis in high-risk populations were obtained and special occupational populations were found. The seroprevalence of brucellosis has been decreasing compared with that reported in the recent years due to the ongoing implementation of control measures in endemic areas.

What are the implications for public health practice?

Special occupational populations could be promptly detected using routine screening, which makes it possible to initiate standardized treatment for infected patients as early as possible. It also reminds us to pay attention to special occupational populations to improve their knowledge of brucellosis and reduce the risk of infection.

Brucellosis is a worldwide zoonotic disease with fever and fatigue caused by gram-negative coccobacilli of the genus *Brucella* (*1*). Human brucellosis is usually linked to direct contact with infected livestock or ingestion of unpasteurized dairy products of infected animals (*2*). Human brucellosis is still a severe public health challenge in most low-income and middle-income areas (*1*). Since the 1990s, the incidence of brucellosis has been increasing and reached a peak in 2014 and ranked in the top 10 most prevalent diseases among the Class A and Class B infectious disease from 2008 to 2018 (*3*). To control brucellosis effectively, the National Brucellosis Prevention and Control Plan (2016–2020) (NBPCP) was formulated by the

Ministry of Agriculture of China and the National Health Commission (NHC) and has begun being implemented for more than 3 years (*4*). The purpose of this study was to investigate the seroprevalence of different high-risk occupational populations in brucellosis-endemic areas in China from 2019 to 2020 and to understand the seroprevalence of the different seasons. A cross-sectional study using an interviewed-based survey was conducted in 4 total counties including 3 counties (Yanggao County, Zuoyun County, and Hunyuan County) in Datong City of Shanxi Province and 1 county (Huocheng County) in Yili District of Xinjiang Uygur Autonomous Region from December 2019 to July 2020. China CDC designed the protocol and implemented relevant training for local CDCs, including administering questionnaires, sampling, and testing, etc. Written informed consent was obtained with face-to-face interviews before the formal inquiry, and the blood samples were collected by the staff of the county CDCs. The participants were aged 18 years and above and were working in livestock breeding, livestock products production and processing, as veterinarians, etc. The sample size is estimated according to the simple random sampling in the cross-sectional survey, the allowable error is 0.15p (p is the expected infection rate,based on other studies, p was at 7%.), and the non-response rate is 10%. The total sample size is initially determined to be 2,400 people, and the sample size for each county is 600 people.

A questionnaire was used to collect epidemiological data associated with brucellosis, and a blood sample was drawn from each participant. Seropositivity was defined with serum standard tube agglutination test (SAT) approach with titer $\geq 1\!:\!100$ (+ +) or $\geq 1\!:\!50$ (+ +) if the course of disease onset lasted more than 1 year according to the Standard for Brucellosis Diagnosis issued by the NHC in 2019 (*5*). Statistical analyses were conducted with R software (version 4.0.2, R Foundation for Statistical Computing,

Austria), and χ^2 test with a significance level of $\alpha = 0.05$ was used to test the difference in proportion.

A total of 2,411 participants were surveyed in this study, 2,384 of them completed the questionnaire and participated in blood collection, and the effective response rate was 98.88% (2,384/2,411). Of them, 1,405 were males (58.93%) and 979 were females (41.07%), and the seroprevalence of brucellosis was 3.06% among males and 1.94% among females. The seroprevalence among males (3.73%) was higher than that among females (1.95%) in Shanxi, and the differences were significant ($P<0.05$). The median age of high-risk populations was 54.5 years (range: 18–91), and the 36–59 age group contained the largest number of participants (49.54%). The seroprevalence in 18–35 age group (4.69%) was higher than that in the 36–59 age group (1.04%) in Xinjiang, and the differences were significant ($P<0.05$). For education level, only 8.93% of participants had senior high school education or above, and the seroprevalence of brucellosis of this group was 3.76%, among which 2 participants with special occupation were brucellosis seropositive (one was part of a local poverty-alleviation cadre in Shanxi and the other was a rural teacher in Xinjiang) (Table 1).

The 62 participants were seropositive for *Brucella* infection, the crude seroprevalence of brucellosis was 2.60% (62/2,384), and that of Shanxi and Xinjiang was 2.91% (52/1,787) and 1.68% (10/597), respectively. Of the 62 seropositive individuals, 20 had ever been diagnosed with human brucellosis before 2019. However, when screening high-risk groups of brucellosis, they were still seropositive for brucellosis. The seroprevalence in fall-winter and spring-summer seasons were respectively 1.71% (20/1,167) and 3.45% (42/1,217) respectively and the differences were significant ($P<0.05$). The serological prevalence of high-risk occupational population in the spring-summer season was higher than that in fall-winter, with the same status in Shanxi province and Xinjiang uygur autonomous region (Table 2).

DISCUSSION

This study was conducted in 2 provincial-level administrative divisions (PLADs) with high incidence of brucellosis from 2019 to 2020. Serological characteristics of high-risk populations were obtained and analyzed. In this study, the seroprevalence of brucellosis among people with high-risk occupations in Shanxi from 2019 to 2020 was 2.91%, which was

significantly lower than the seroprevalence of brucellosis in Shanxi from 2013 to 2016 (6.15%)(6). The seroprevalence of brucellosis among people with high-risk occupations in Xinjiang from 2019 to 2020 was 1.68%, which was significantly lower than the seroprevalence of brucellosis in Xinjiang from 2012 to 2015 (16.86%)(7). All these achievements benefitted from early screening of high-risk populations, health education, and behavioral interventions. The agriculture departments also improved livestock vaccination and strengthened animal quarantining. At the same time, the implementation of NBPCP has achieved good results.

The seroprevalence of brucellosis in Shanxi was 2.91%, and that in Xinjiang was 1.68%, but there was no significant difference brtween them ($P>0.05$). These may be due to 2 reasons: 1) differing methods of livestock breeding between the 2 PLADs; and 2) the poor knowledge of human brucellosis and the lack of utilization of personal protective equipment (PPE), which was concurrently reported by Wang Z et al (8). The cohabitation between humans and their livestock was identified among some families during the field survey in Shanxi, which increased the risk of brucellosis transmission.

Screening of high-risk populations can facilitate early disease detection to provide better disease incidence estimates and reduce disease complications. In this study, two special participants were identified among brucellosis patients, including a rural teacher and a member of the poverty-alleviation cadre. There may be two main reasons: 1) they were relatively young and came from areas where brucellosis is not endemic and had no knowledge of human brucellosis; 2) they have low awareness of brucellosis or do not know how to use PPE correctly. The health education and behavior intervention measures are vital to individuals who are undertaking national or local poverty-alleviation missions, including township or village officials and teachers, to properly use PPE when they are exposed to risk environments or engaged in high-risk occupations.

Considering the epidemiological characteristics of human brucellosis, the study was conducted in the fall-winter 2019 and spring-summer 2020. The results indicated that the related occupational populations had a higher risk of infection during spring and summer because this period is the peak lambing periods for cattle, sheep, and other livestock, and 90% of human brucellosis also occurs at this time (9). Furthermore, brucellosis incidence was also strongly associated with

TABLE 1. Serological prevalence and comparative analysis of different demographic characteristics of high-risk populations of brucellosis in Shanxi and Xinjiang from 2019 to 2020.

Features	Total					Shanxi				Xinjiang			
	Number of participant	Percentage (%)	Seropositive	Seroprevalence (%)	P-value	Number of participant	Seropositive	Seroprevalence (%)	P-value	Number of participant	Seropositive	Seroprevalence (%)	P-value
Gender					0.091				0.026*				1.000
Male	1,405	58.93	43	3.06		966	36	3.73		439	7	1.59	
Female	979	41.07	19	1.94		821	16	1.95		158	3	1.90	
Age group (years)					0.368				0.447				0.019*
18–35	181	7.59	7	3.87		53	1	1.89		128	6	4.69	
36–59	1,181	49.54	32	2.71		798	28	3.51		383	4	1.04	
≥60	1,022	42.87	23	2.25		936	23	2.46		86	0	0	
Education					0.595				0.793				0.211
Illiteracy	508	21.31	13	2.56		434	12	2.76		75	1	1.33	
Primary school	996	41.78	22	2.21		758	20	2.64		239	2	0.84	
Junior high school	667	27.98	19	2.85		515	17	3.30		153	2	1.31	
Senior high school and above	213	8.93	8	3.76		80	3	3.75		130	5	3.85	
Occupation					0.417				0.456				0.051
Farmer	1,952	81.88	50	2.56		1,689	48	2.84		263	2	0.76	
Herder	260	10.91	6	2.31		75	3	4.00		185	3	1.62	
Livestock processing	7	0.29	0	0		3	0	0		4	0	0	
Teacher	8	0.33	1	12.50		2	0	0		6	1	16.67	
Medical staff	22	0.92	0	0		6	0	0		16	0	0	
Veterinary	72	3.02	4	5.56		2	0	0		70	4	5.71	
Caterer	8	0.34	0	0		0	0	0		4	0	0	
Student	1	0.04	0	0		1	0	0		0	0	0	
Other	54	2.27	1	1.85		9	1†	11.11		49	0	0	

Note: Seroprevalence (%)=number of seropositivity/number of participants×100%.
* The different demographic characteristics was statistically significant (P<0.05).
† The only one case of brucellosis seropositive in other occupations was a local poverty-alleviation cadre.

TABLE 2. The overall serological prevalence and comparative analysis of high-risk population of brucellosis in different seasons in Shanxi and Xinjiang from 2019 to 2020.

Unit	Total				Fall-Winter season			Spring-Summer season			
	Number of participant	Seropositive	Seroprevalence (%)	P-value	Number of participant	Seropositive	Seroprevalence (%)	Number of participant	Seropositive	Seroprevalence (%)	P-value
Shanxi	1,787	52	2.91	0.101	871	17	1.95	916	35	3.82	0.019*
Yanggao County	599	3	0.50		271	3	1.11	328	0	0	
Hunyuan County	587	35	5.96		295	11	3.73	292	24	8.23	
Zuoyun County	601	14	2.33		305	3	0.98	296	11	3.72	
Xinjiang	597	10	1.68		296	3	1.01	301	7	2.33	0.352
Huocheng County	597	10	1.68		296	3	1.01	301	7	2.33	
Total	2,384	62	2.60		1,167	20	1.71	1,217	42	3.45	0.008*

Note: Seroprevalence (%)=number of Seropositivity/number of participants×100%. Fall-winter season: December 2019 to January 2020; Spring-summer season: April to July 2020.
* The difference between the two seasons was significantly (P<0.05).

lambing of livestock, handling of aborted products, or improper personal protection behaviors (*3,10–11*).

This study was subject to two limitations. First, China CDC did not review 20% of seropositive samples due to COVID-19 outbreak, which might cause some uncertainties in the results. Second, only 3 counties in Shanxi and 1 county in Xinjiang were investigated, so the results might not be widely generalizable.

In summary, although the seroprevalence of brucellosis in endemic areas of China has decreased, some high-risk occupational populations still have the risk of being infected with brucellosis, especially some special occupational populations, such as rural teachers and poverty-alleviation cadres. It is necessary to expand the scope of brucellosis education, especially to strengthen the health education and behavioral intervention measures, to improve their awareness of brucellosis and their ability to protect against it and reduce the risk of infection. Moreover, the results can provide some evidence for future evaluation work from the NBPCP and can be used to guide the local health departments on brucellosis prevention and control work.

Ethical Approval and consent to participate: The study design obtained ethical approval following a review by China CDC Institutional Review Board. Written informed consent has been obtained from the patients in accordance with the Declaration of Helsinki. The research group confirmed that the identification information of all participants (including patient names, ID numbers, home addresses and telephone numbers) would not be included in recordings, descriptions, or publications.

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