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Epidemiological survey of human brucellosis in Inner Mongolia, China, 2010–2014: A high risk groups-based survey

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ABSTRACT

Brucellosis, a zoonosis which can seriously harm public health. Inner Mongolia is known as an endemic region of human brucellosis in China. The aim of this study is to present the epidemic of human brucellosis in Inner Mongolia from 2010 to 2014, and to provide the evidence of preventing from brucellosis in endemic areas. The study included 838,956 participants by cluster random sampling from 2010 to 2014. The contents of this study included questionnaire survey and serological testing. The seropositive rate was calculated based on the serological testing results, tested to determine whether the participants were infected by brucellosis. The new brucellosis cases were diagnosed using the questionnaire data and serological testing results then and the incidence rate was obtained. We also plotted spatial distribution maps based on the seropositive and incidence rate of human brucellosis. The total seropositive and incidence rate of human brucellosis among the high risk groups in Inner Mongolia from 2010 to 2014 was 35.91‰ and 18.25‰, respectively. The epidemic of the mid-eastern Inner Mongolia was decreased, however, the epidemic has worsened in western Inner Mongolia. Despite the epidemic of human brucellosis among the high risk groups of Inner Mongolia decreased significantly from 2010 to 2014, increased prevention and control measures are urgently needed.

Introduction

Brucellosis, a zoonosis caused by *Brucella* species, can seriously harm human health. The disease affects people of all age groups and of both sexes [1]. The main sources of infection are the infected small ruminants and cattle [2]. Most brucellosis cases are likely to be the people who engage in breeding, grazing, slaughtering of the animals, and pathogenic infection occurs by direct or indirect contact with infected livestock or their products [1,3]. Major symptoms of the patients were characterized by *Brucella* include weakness, lethargy, fever, and disability. Since the course of the disease can be several years or even decades, it can been considered as a critical public health threat to the population [4].

According to a previous study, human brucellosis caused more than 500,000 new cases annually [5]. In most developed countries, brucellosis had been effectively controlled or eliminated. However, human brucellosis has become endemic infectious disease in developing nations. Some countries in central Asia such as Mongolia have been traditionally considered endemic areas [4]. The incidence of human brucellosis in Mongolia is ranked second worldwide [6]. Mongolia is similar to Inner Mongolia (a northern province of China) both in geography and culture.

Previous studies has reported that human brucellosis had been prevalent until the mid-1980s in China, with a subsequent gradual decline after that period [7]. However, the disease rebounded significantly and showed rapid growth after the 1990s in this country especially at the beginning of 21st century [8].

With well-developed animal husbandry production, Inner Mongolia is known as an endemic region of human brucellosis in China [9,10]. The incidence of human brucellosis was also at lower levels during 1971–1994 in Inner Mongolia. However, incidence rate had been increasing since 1995, reaching 6.86 cases per million in 2009. Although the incidence showed a slight decline in 2010 [11], the incidence rate in Inner Mongolia remained the highest in China at 6.56 cases per million.

Before 2010, the brucellosis data were collected by the National Notifiable Disease Surveillance System of Inner Mongolia. However, according to a previous research, the data reported from this system were likely to be underestimated in Inner Mongolia [8]. In addition, since human brucellosis has a strong work-relatedness, people engaged in agricultural cultivation or breeding, grazing, slaughtering, processing and selling of livestock are the high risk groups for human brucellosis monitoring. In this study, we presented the

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seropositive and incidence rate among these high risk groups and showed the human brucellosis epidemic in Inner Mongolia from 2010 to 2014. Since there is a possibility of missing data in National Notifiable Disease Surveillance System as mentioned above, this study is designed as the first study which may systematically provide a complete overview of the epidemic of brucellosis among high risk groups in Inner Mongolia. Therefore, the findings are crucial for prevention and control of human brucellosis in endemic areas.

Materials and methods

Participants

The data in this study were extracted from Endemic Disease Control and Research Center of Inner Mongolia. From 2010 to 2014, cluster random sampling was used in the villages (communities) of all the 12 cities of Inner Mongolia. From east to west, the cities include Hulunboir, Hinggan, Tongliao, Chifeng, Shilingol, Ulanchav, Hohhot, Baotou, Bayannuur, Erdos, Wuhai and Alsha. We selected high risk groups engaged in agricultural cultivation or breeding, grazing, slaughtering, processing and selling of livestock in these villages as research participants. During this period (5 years), the investigation to 105 villages was conducted and the total number of the participants was 838,956. The research included questionnaire survey and serological testing. All the researchers of the survey participated in a professional training course before the research.

The questionnaire survey was conducted using face-to-face interviews. The contents of survey mainly include socio-demographic factors, risky behaviors, safeguard procedures, and the presence of specific symptoms in the previous month. The risky behaviors and safeguard procedures include exposure history to infected livestock and their products in the previous month, and use of personal protective equipment (PPE) during conducting risky operations.

Serological testing

5 milliliters of venous blood were collected for each participant. The venous blood was centrifuged for five minutes at 3000 rounds per minute and the separated serum was kept frozen in cool boxes and transported to the local Disease Control and Prevention Center (CDC) for serological testing. Blood samples then were tested by serum agglutination test (SAT). Antibody titers $\geq$1:100++ were considered positive. In this study, no matter with or without presence of clinical symptoms, the participants who showed positive results were considered seropositive. All the serological testings in CDCs were under a strict quality control of previously trained qualified supervisors and the reagents used for the testing were provided by Chinese Center for Disease Control and Prevention (CCDC).

Diagnostic of brucellosis

New brucellosis cases were diagnosed according to the "2007 Diagnostic Criteria of Brucellosis (WS268-2007)"of Chinese Ministry of Health and each new case in this study was confirmed not having previous history of Brucellosis. The inclusion criteria for the cases are:

1) Contacted with *Brucella* previously or living in endemic areas;
2) Presence of clinical symptoms such as high fever, myalgia, and arthralgia of the large joints;
3) Positive serological testing result. Serological testings include the standard plate agglutination test (PAT) and/or rose bengal plate test (RBPT) and/or serum agglutination test (SAT), or bacterial isolation. In this study, we used SAT for serological testing.

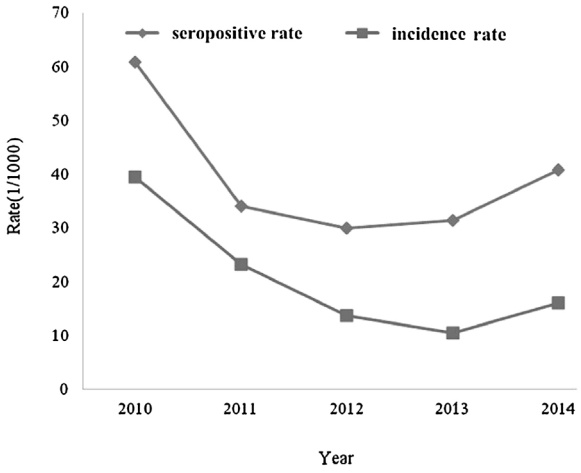

Fig. 1. Seropositive and incidence rate of human brucellosis among high risk groups in Inner Mongolia, 2010–2014.

Data analysis

The data were analyzed by IBM SPSS software, Version 19.0 (IBM Corp., Armonk, NY, USA), and the spatial distribution maps were plotted using ArcGIS Release 10.2 (Esri, Redlands, CA). We plotted spatial distribution based on the seropositive and incidence rate of human brucellosis on digital regional maps.

Results

The total seropositive and incidence rate of human brucellosis among the high risk groups in Inner Mongolia during 2010–2014 was 35.91‰ and 18.25‰, respectively. Seropositive rate showed a decreasing trend between 2010 and 2012, and then showed a slightly increasing trend. Incidence rate showed a decreasing trend from 2010 to 2013, and then showed a slightly increasing trend. The seropositive rate was higher than the incidence rate during all time period (Fig. 1).

Seropositive rate of human brucellosis among high risk groups in Inner Mongolia, 2010–2014

Among all the survey participants, 30,131 participants were tested seropositive. The total seropositive rate was 35.91‰ over the 5-year time period, and the seropositive rate in 2012 showed the lowest.

The seropositive rate and its spatial distribution were shown in Table 1 and Fig. 2. Seropositive rate of Shilingol was the highest in 2010. Relatively higher seropositive rates were found in the cities such as Hinggan, Chifeng and Shilingol in 2011, and that was in Hulunboir and Shilingol in 2012. The seropositive rate in all cities decreased in 2013, except that remained high in Chifeng and Hulunboir. Hinggan had the highest seropositive rate in 2014. The seropositive rate had a decreasing tendency in most cities, however, the rate increased by three to five times in western cities.

Incidence rate of human brucellosis among high risk groups in Inner Mongolia, 2010–2014

Over the 5-year study period, there were 15,315 new cases of brucellosis and the total incidence rate was 18.25‰, with the lowest incidence rate in 2013.

Table 2 and Fig. 3 showed the incidence rate and its spatial distribution of human brucellosis, respectively. In 2010 and 2011, the incidence rate was highest in Hinggan and the incidence rates in all

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