## Original Article

# Diversity and Distribution of Host Animal Species of Hantavirus and Risk to Human Health in Jiuhua Mountain Area, China*

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**Abstract**

**Objective** To investigate the diversity and the distribution of host animal species of hantavirus and the effect on human health in Jiuhua Mountain area, China.

**Methods** The host animal species of hantavirus was surveyed by using the trap method and the species diversity was evaluated by using the Simpson, Shannon-Weaner, and Pielou indices. Hantavirus antigens or antibodies in lung and blood samples of all the captured host animals were detected by direct or indirect immunofluorescence.

**Results** Nine animal species of hantavirus were distributed in the forest ecosystem of Jiuhua Mountain. Of these, *Niviventer confucianus* and *Apodemus agrarius* were predominant, and *N. confucianus*, *Rattus norvegicus*, and *Mus musculus* had relatively large niche breadth index values. The host animals in the eastern and western mountain regions shared similar biodiversity index characteristics, predominant species, and species structures. Hantavirus was detected in 5 host animal species in Jiuhua Mountain area, the carriage rate of hantavirus was 6.03%. The average density of host animals in forest areas of the mountainous area was only 2.20%, and the virus infection rate in the healthy population was 2.33%.

**Conclusion** The circulation of hantavirus was low in the forest areas of Jiuhua Mountain and did not pose a threat to human health.

**Key words:** Hantavirus; Host animal; Diversity and distribution; Risk assessment; Jiuhua Mountain

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## INTRODUCTION

Hantaviruses carried by numerous wild mammal animals are zoonotic pathogens which have previously caused severe diseases in humans, and are widely distributed throughout most of Europe, Asia, and the Americas[1]. Hantaviruses can cause hemorrhagic fever with renal syndrome (HFRS), a severe acute infectious disease, in Europe and Asia, and hantavirus pulmonary syndrome (HPS), another fatal disease, in the Americas[2-4]. However, the numbers of cases and deaths of HFRS in China remain the highest in the world. From 1950 to 2007, a total of 1,557,622 cases

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of HFRS and 46,427 deaths in humans were reported in China and the death rate averaged about 3%[5]. However, the mortality rate from HPS in the Americas is even higher. When an outbreak of HPS in the southwest of the United States occurred in 1993, the mortality rate reached 70% within the first few weeks, and subsequently fell to about 40%[6].

As far as we know, more than 170 species of mammals have been confirmed to carry hantaviruses in nature, most of them are rodents. However, the competent viral reservoir hosts which are responsible for HFRS and HPS outbreaks in different regions across the world are not all the same rodent species. The main reservoir for Sin Nombre Virus (SNV) which caused the 1993 HPS outbreak in the North America was identified as the deer mouse (*Peromyscus maniculatus*)[7-8]. However, the main host for Puumala Virus (PUUV) which caused HFRS outbreak in Europe is bank vole (*Clethrionomys glareolus*), and the striped field mouse (*Apodemus agrarius*) is the most important viral host in China. In 1991, when an outbreak of HFRS occurred in Huaihe River Valley, China, the infection rate in the striped field mice was as high as 51.1%[9].

There are many factors influencing hantavirus circulation, such as human activity, environmental conditions, climate change, reservoir host ecology, host-virus relationships, etc. In recent years, scientists have studied the influence of host diversity on disease risk because they believe that species diversity also plays a key role in governing pathogen circulation[10]. The ecological research for risk of exposure to Lyme disease suggests that high reservoir species diversity results in a 'dilution effect' which causes a dilution in the capacity of white-footed mice (*Peromyscus leucopus*) (the most competent reservoir host for Lyme disease agent) to infect ticks. High species diversity therefore results in lower prevalence of infection in ticks and decreases the risk of Lyme disease to humans[11]. The dilution effect can also be observed in the relationship between the incidence of human West Nile virus (WNV) infection and avian (host) diversity in the United States, where non-passerine diversity may play a role in dampening WNV amplification rates in mosquitoes, minimizing human disease risk[12]. However, scientists found that experimental evidence for reduced rodent diversity causing increased hantavirus circulation. Both infection prevalence of hantaviruses in wild reservoir (rodent) populations and reservoir population density increased where small-mammal species diversity was reduced[13]. Another investigation into hantavirus-host relationships indicated an increase in rodent species diversity, which also caused an increase in the number of predators of the rodent host species. This could keep rodent numbers under control, in turn limiting pathogen spread both among rodents and into human populations[14]. In fact, each outbreak of hantaviral disease is associated with a higher density of competent host species and the carriage of hantaviruses in host species. Nowadays, researchers would rather make use of the density of wild host species and the circulation level of the virus among these species as an early warning indicator of a disease outbreak[15-16].

HFRS, which has become an epidemic on 4 occasions, and has accumulated nearly 100,000 cases, occurs along the plains of Huaihe River and Yangtze River in Anhui Province, China. The area affected by HFRS has also expanded[17]. In the early 1990s, a small focus of HFRS infection was found in the mountain forest area in Anhui Province, suggesting the possibility of hantavirus epidemics within mountainous areas[18]. Research indicates that declines in the diversity of host animals will lead to increases in the epidemic strength of viruses within hosts[13]. Thus, investigations into rodent diversity in mountainous areas can help elucidate the potential existence of risk factors of hantavirus epidemics in mountainous areas. Biodiversity is generally higher at lower latitudes than at high latitudes. However, the species richness of mammals is significantly higher in mountainous area than in plain and hilly areas in Anhui Province, and the Wannan Mountainous area in southern Anhui[19] has the highest elevation in this region. Jiuhua Mountain, with an elevation of >1300, lies in Qingyang County in Wannan. The Jiuhua Mountain National Forest Park has a high forest coverage rate and high animal habitat diversity. However, limited information is available in the relationship between the diversity of viral hosts and the effect they have on human health in Jiuhua Mountain area. This study investigates the diversity of host animals and the distribution of hantavirus in host animals in Jiuhua Mountain and further assessed the infection risk in a human population in this area.

## MATERIALS AND METHODS

### *Selection of Survey Area*

Jiuhua Mountain area consists of farmland on