Original Article

Dynamics of Rodent and Rodent-borne Disease during Construction of the Three Gorges Reservoir from 1997 to 2012*

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Abstract

Objective To investigate the impact of impoundment and active public health interventions on rodent populations and rodent-borne diseases in the Three Gorges reservoir region from 1997 to 2012.

Methods Surveillance data from 1997 to 2012 were extracted from the Public Health Surveillance System of The Three Gorges established in 1997. Temporal changes in the incidences of hemorrhagic fever with renal syndrome (HFRS) and leptospirosis, rodent density, pathogen-carrying rates, and their correlations were analyzed.

Results The average indoor and outdoor rodent densities decreased overall from 1997 to 2012. The average densities decreased by 47.72% (from 4.38% to 2.29%) and 39.68% (from 4.41% to 2.66%), respectively, after impoundment (2003-2012) compared with before impoundment (1997-2002). The average annual incidence rates of HFRS and leptospirosis were 0.29/100,000 and 0.52/100,000, respectively, and decreased by 85.74% (from 0.68/100,000 to 0.10/100,000) and 95.73% (from 1.47/100,000 to 0.065/100,000), respectively, after impoundment compared with before impoundment. Incidences of HFRS and leptospirosis appear to be positively correlated with rodent density in the reservoir area.

Conclusion This study demonstrated that rodent density and incidences of rodent-borne diseases decreased and were maintained at low levels during construction of the Three Gorges dam. Measures that reduce rodent population densities could be effective in controlling rodent-borne diseases during large-scale hydraulic engineering construction.

Key words: Three Gorges reservoir; Rodent density; Rodent-borne diseases

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INTRODUCTION

The Three Gorges Reservoir (TGR) in China, the world's largest hydropower project, was initiated in 1994 and was completed in 2009[1]. The Three Gorges Reservoir Region (TGRR) is located between latitude 28°56'-31°44' north and longitude 106°16'-111°28' east, with a total area of 58,000 km^2, involving 19 counties and municipalities between Chongqing and Yichang City. The construction period of the TGR was separated into three distinct phases, with phase III full implementation of the hydroelectric facilities from 2003-2009. The TGR first began storing water in 2003; since that time, water levels have increased more than 70 m to 135 m. After completion of the Three Gorges project in 2009, the water storage level went to 175 m and a huge reservoir 1084 km^2 in area and 39.3 billion m^3 capacity was formed. As a result, large areas of agricultural, forest, and grassland ecosystems will be inundated and 1.13 million people will eventually be resettled[1]. The natural environments, regional climates, and lifestyles of local residents in the TGRR have been affected. Although the Three Gorges hydropower project has great potential benefits for flood control, power generation, and navigation, its impact on population health has been a concern.

Before construction of TGR, health assessment surveys performed by experts in China indicated that hemorrhagic fever with renal syndrome (HFRS) and leptospirosis were diseases endemic to the TGRR. Rodents, as the host-animal of these diseases, are very sensitive to changes in their habitat environments due to food and habitat limitations, as well as climate change caused by rising water levels, which may lead to changes in density and species, thus leading to variation in disease transmission intensity[2-3].

In order to avoid outbreaks or epidemics of rodent-borne infectious diseases due to reservoir construction[4], many control measures, such as deratization and enhanced monitoring of rodent and rodent-borne infectious disease, were undertaken during reservoir construction. However, to our knowledge, the effects of the deratizations on the abundance and diversity of rodent species as well as incidences of rodent-borne diseases have not yet been assessed.

In this study, we investigated the dynamics of rodent-borne disease and rodent populations during implementation of deratization measures from 1997 to 2012. The information can be used to inform disease control measures for large-scale hydraulic engineering projects.

METHODS

The Public Health Surveillance System

The Public Health Surveillance System of the TGRR was established in 1997. Based on the historical epidemiology of rodent-borne infectious diseases, geographical landscape, flood situation, and rodent habits, rodent monitoring and assessment of the incidence of rodent-borne infectious diseases were conducted in 19 townships of five surveillance points in the TGRR near the Yangtze River. These five surveillance points were distributed throughout the Central Districts of Chongqing, Fengdu, Wanzhou, Fengjie, and Yichang (where the Three Gorges Dam is located). The distance between adjacent surveillance points is about 150 kilometers. The 19 townships are located at about the same altitudes and within 3 kilometers of the Yangtze River, as shown in Figure 1.

Surveillance of Rodent Density and Composition

Rodent surveillance surveys were conducted twice yearly in the TGRR from 1997 to 2012, on April 15th and September 15th. At least 130 medium-sized steel traps were set at each surveillance location in either indoor or outdoor areas (including crop fields, vegetable fields, and wastelands) likely to be habitats for rodent reservoirs, using the following approach. Traps baited with peanuts were set at night and recovered the next morning. One indoor trap was placed approximately every 15 m^2 and no more than three traps were placed in each household. Outdoor traps were placed in rows at intervals of approximately five meters, with 50-meter intervals between rows. Captured rodents were identified at a species level and their gender and maturity were recorded. The relative rodent densities were calculated using the following formula: rodent density = number of captured rodents/number of effective traps × 100%.

Hantavirus and Leptospira Detection in Lung and Kidney Samples

All captured rodents were transferred to the laboratory and their lung and kidney tissues collected. A minimum of 35 captured rodents were required from each surveillance location. No fewer