Risk evaluation of schistosomiasis japonica input to the Chaohu Lake region in Anhui province of China

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Outline

• Schistosomiasis japonica and its control in China

• Brief instruction of water transfer project from the Yangtze River to the Huaihe River and its potential impact on schistosomiasis japonica

• Risk evaluation of schistosomiasis japonica input to the Chaohu Lake region caused by the water transfer project from the Yangtze River to the Huaihe River
Schistosomiasis japonica and its control in China

- Schistosomiasis japonica, caused by *Schistosoma japonicum*, is mainly prevalent in China, the Philippines and Indonesia, and China is the most heavily endemic of the three countries.

- In the past, many famous terms, such as “Village without villagers”, “Widows villages”, and “Big-belly villages”, were used to describe the devastating consequences the disease brought to the Chinese people.
In 1971, the eggs of *Schistosoma japonicum* were found from an ancient female corpse of Western Han dynasty (167 B.C.) in Changsha indicates that the disease has been prevalent in China for more than 2000 years.
A large-scale epidemiological survey at the beginning of 1950s found that:

- The disease was endemic in 373 counties of 12 provinces
- 11.6 million people were infected
- More than 100 million people were at risk of infection
- 1.2 million cattle were infected
- The habitat area of *Oncomelania snails* (the intermediate host of *S. japonicum*) reached 14.3 billion m$^2$

Geographic distribution of schistosomiasis in China in 1950s
How to effectively control schistosomiasis?
A national control programme has been launched since the mid 1950s, and an integrated control strategy has been applied with different focus in different phases:

- **From 1956 to 1984:** more focus on snail control
- **From 1985 to 2003:** more focus on morbidity control based on chemotherapy with praziquantel
- **From 2004 to now:** more focus on infectious source control
• Great achievements have been obtained in the past six decades

By the end of 2012, among 12 endemic provinces:

• **Transmission interruption**: Guangdong, Shanghai, Fujian, Guangxi, and Zhejiang

• **Transmission control** (both human and livestock prevalence less than 1%): Sichuan, Yunnan, and Jiangsu

• **Infection control** (both human and livestock prevalence less than 5%): Hubei, Hunan, Jiangxi, and Anhui

Among 452 endemic counties, transmission interruption: 281 (62.17%); transmission control: 100 (22.12%); infection control: 71 (15.71%)
Compared situation in 2012 with that in 1950s:

- **Number of infected people**: decreased from 11.6 million to 0.24 million, reduced by 97.9%
- **Number of acute cases**: decreased from over 10000 cases to 13
- **Number of infected cattle**: decreased from 1.2 million to less than 0.01 million
- **Area of snail habitat**: decreased from 14.3 billion m$^2$ to 3.7 billion m$^2$, reduced by 74.1%

(Li Shi-zhu, *et al.*, 2013)
Geographic distribution of schistosomiasis in China in 2012

- Transmission interrupted area
- Transmission control area
- Infection control area
• Having noted the above achievements, there are still many major challenges, such as:

  • Effects of climate change and flood disaster
  • Infection of mobile population
  • Lack of highly sensitive surveillance and response system
  • Impact of water transfer project
• Brief instruction of water transfer project from the Yangtze River to the Huaihe River and its potential impact on schistosomiasis japonica
Functions of the water transfer project from the Yangtze River to the Huaihe River

- To alleviate water shortage of northern Anhui Province
- To improve ecological environments of the Chaohu Lake and the Huaihe River
- To improve shipping requirement between the two rivers
Water transfer routes

- Chaohu Lake
- Huaihe River
- Yangtze River

Distances:
- 157 km
- 115 km
- 115 km
Schistosomiasis situation in Anhui in 2013

Non-endemic
Infection control
Transmission control
Transmission interruption
Water system

Schistosomiasis situation in Anhui in 2013

1:3076715
The Chaohu Lake

• Basin area: 13,486 km²
• Location: N 31°25′ - 31°43′
  E 117°16′-117°51′

No *Oncomelania* snails were found in the lake in history.
• Risk evaluation of schistosomiasis japonica input to the Chaohu lake region caused by water transfer project from the Yangtze River to the Huaihe River
Objectives

- To predict weather exogenous *Oncomelania* snails of endemic areas along the water transfer route can spread into the Chaohu Lake after completion of the project.

- To understand weather *Oncomelania* snails can survive and reproduce in the lake.

- To understand weather there were schistosomiasis infectious sources in the lake region.
Methods

• From 2008 to 2012, the snail spreading pattern was conducted through salvaging floaters in rivers connected with the Yangtze River and the Chaohu Lake.

• From 2008 to 2012, the distribution of *Oncomelania* snails was investigated in risk areas and suspicious areas in the Chaohu Lake region.
Oncomelania snails were raised in the cages on the beaches of the Chaohu Lake and a control area in endemic areas from 2007 to 2010, and their survival and reproduction capacity was observed.
• From 2008 to 2012, 1 fixed and 3 mobile surveillance sites in the Chaohu Lake region were selected, and the schistosomiasis infection of local people, mobile population and livestock were investigated.

• All people were firstly screened by immunological assays, and the positive ones were then investigated by stool examination methods; and all livestock were investigated by stool hatching method.
## Results

Table 1 Investigation results of *Oncomelania* snail spreading patterns from 2008 to 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Weight of floating debris (kg)</th>
<th>No. <em>Oncomelania</em> snails captured</th>
<th>No. other kind of snails captured</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>93.6</td>
<td>11</td>
<td>480</td>
</tr>
<tr>
<td>2009</td>
<td>166.0</td>
<td>0</td>
<td>260</td>
</tr>
<tr>
<td>2010</td>
<td>66.0</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>2011</td>
<td>83.0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>2012</td>
<td>49.0</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>457.6</td>
<td>11</td>
<td>819</td>
</tr>
</tbody>
</table>
From 2008 to 2012, a total of 1630 km² in risk areas and 3551 km² in suspicious areas in the Chaohu Lake region were surveyed, but there were no *Oncomelania* snails found.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. environments investigated</th>
<th>Area investigated (km²)</th>
<th>No. frames</th>
<th>No. frames with snails</th>
<th>No. snails captured</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>6</td>
<td>139.4</td>
<td>836</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>17</td>
<td>1548.8</td>
<td>2956</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>7</td>
<td>248.0</td>
<td>1330</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>1612.7</td>
<td>2570</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>12</td>
<td>2.1</td>
<td>521</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3551.0</td>
<td>8213</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Table 3</td>
<td>Survival rate of <em>Oncomelania</em> snails in the Chaohu Lake from 2007 to 2010(%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Observation area</td>
<td>2007.06</td>
<td>2008.06</td>
<td>2009.06</td>
<td>2010.06</td>
</tr>
<tr>
<td>Trial area</td>
<td>Mawei river</td>
<td>88(86/98)</td>
<td>51(45/89)</td>
<td>35(25/71)</td>
<td>24(20/84)</td>
</tr>
<tr>
<td></td>
<td>Shanheng</td>
<td>92(85/92)</td>
<td>54(50/92)</td>
<td>23(12/52)</td>
<td>16(13/79)</td>
</tr>
<tr>
<td>Control area</td>
<td>Liudu</td>
<td>96(85/89)</td>
<td>52(44/85)</td>
<td>26(18/69)</td>
<td>18(14/76)</td>
</tr>
<tr>
<td></td>
<td>$\chi^2$ Value</td>
<td>3.78</td>
<td>0.27</td>
<td>2.51</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>$P$ Value</td>
<td>0.151</td>
<td>0.873</td>
<td>0.285</td>
<td>0.472</td>
</tr>
<tr>
<td>Table 4</td>
<td>Number of filial generation snails in each area from 2007 to 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Observation area</td>
<td>2007.06</td>
<td>2008.06</td>
<td>2009.06</td>
<td>2010.06</td>
</tr>
<tr>
<td>Trial area</td>
<td>Mawei river</td>
<td>0</td>
<td>172</td>
<td>311</td>
<td>296</td>
</tr>
<tr>
<td>Shanhen</td>
<td>0</td>
<td>156</td>
<td>246</td>
<td>274</td>
<td></td>
</tr>
<tr>
<td>Control area</td>
<td>Liudu</td>
<td>0</td>
<td>189</td>
<td>287</td>
<td>312</td>
</tr>
</tbody>
</table>
• The schistosomiasis infection situation of 615 local residents in the fix surveillance site of the Chaohu Lake region was investigated in autumns of 2008 and 2012, but there were no positive found.

• From 2008 to 2012, a total of 1603 mobile population of the region were examined by indirect hemagglutination assay (IHA), and the positive rate of antibody was 3.1%; 75 individuals were investigated by stool examination method, and the positive rate was 36.00%.

• A total of 303 livestock were examined by stool hatching method, but no one showed positive.
### Table 5  Schistosomiasis infection status of mobile population in the Chaohu Lake region from 2008 to 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Serological examination</th>
<th></th>
<th>Stool examination</th>
<th></th>
<th>Infection rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. examined</td>
<td>No. positives</td>
<td>Positive rate(%)</td>
<td>No. examined</td>
<td>No. positives</td>
</tr>
<tr>
<td>2008</td>
<td>321</td>
<td>12</td>
<td>3.7</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>2009</td>
<td>362</td>
<td>18</td>
<td>5.0</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>2010</td>
<td>306</td>
<td>9</td>
<td>2.9</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>2011</td>
<td>312</td>
<td>6</td>
<td>1.9</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2012</td>
<td>302</td>
<td>4</td>
<td>1.3</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>1603</td>
<td>49</td>
<td>3.1</td>
<td>75</td>
<td>27</td>
</tr>
</tbody>
</table>
Conclusions

- After completion of water transfer project from the Yangtze River to the Huaihe River, the possibility of imported exogenous *Oncomelania* snails spreading into the Chaohu Lake and surviving and reproducing there is high.
- The imposed infectious sources of schistosomiasis japonica have been found in the Chaohu Lake region.
- The project has obvious impact on the transmission of schistosomiasis japonica, and the risk of the disease input to the Chaohu Lake region is predicted to be high, which indicates that a long term surveillance scheme on schistosomiasis should be established in the region.
Thank you!