ANALYSIS OF SOCIAL FACTORS AND HUMAN BEHAVIOR ATTRIBUTED TO FAMILY DISTRIBUTION OF SCHISTOSOMIASIS JAPONICA CASES

Zheng Jiang[1], Zheng Qing-si[2], Wang Xian-feng[1], Guan Li-zhong[2] and Hua Zheng-hui[1]

[1]Institute of Parasitic Diseases, Chinese Academy of Preventive Medicine, 207 Rui Jin Er Lu, Shanghai, People's Republic of China; [2]Institute of Epidemiology and Microbiology, Chinese Academy of Preventive Medicine, Beijing, People's Republic of China

Abstract. An investigation of family distribution patterns of schistosomiasis japonica was carried out in four pilot villages in Yunnan Province. Family clustering of the disease was present in Bihuayuan Village before and after economic reform (site A); however, such clustering did not occur in Tuanshan and Liantie Villages (sites B and C) in the same periods. Being contrary to the stage prior to economic reform family clustering existed in Zhonghe Village (site D) after the reform. The results obtained from single- and multi-factor analysis showed that the main human behavior related to family distribution of schistosomiasis in mountainous regions of Yunnan Province included the frequency of laborer migration, contact with cercariae-infested water in public places or family microenvironments with a high transmission potential, promiscuous defecation and status of cattle grazing. The frequency of laborer migration and human contact with cercariae-infested water in public places in sites B and C without family clustering was higher than that in sites A and D with family clustering. Place for promiscuous defecation and cattle grazing in site A converged compared with that in sites B and C.

INTRODUCTION

In 1989, family clustering of schistosomiasis cases was first reported in Zhonghe Village, Weishan Country, Yunnan Province (Zheng *et al*, 1989). It was also noted in Sichuan Province (Jin, 1989) and in Bihuayuan Village of Eryuan County, Yunnan Province. On the other hand, it has been reported that family clustering of schistosomiasis cases was not obvious in Liantie and Haikou villages, Eryuan County. Zheng *et al* (1989) pointed out that the changes of human behavior and activities of domestic animals due to economic reform contributed to family clustering of schistosomiasis cases. However, there was no further report on the influence of socio-economic factors and human behavior on family distribution patterns of schistosomiasis cases.

MATERIALS AND METHODS

Introduction of pilot areas

Four typical endemic villages of schistosomiasis with well-documented historical record, data of schistosomiasis cases and *Oncomelania* snail habitats at village and country level were selected as pilot areas.

1) Liantie Village, a highly endemic area in a plateau valley at the altitudes of about 1,700 m to 2,350 m, is located on the mountain slope with terrace topography where rice, corn and wheat are the main crops. The recent number of inhabitants, mainly Bai minority nationality, was 518 in 97 households. Many spots with high transmission potentially existed; the infection rates of residents and cattle in 1987 were 22.6%-45.8% and 34.2%, respectively (Chen, 1989).

2) Bihuayuan Village, a highly endemic area of mountainous plateau, is located at an altitude of 2,010 m. The inhabitants, mainly Bai minority, were 560 in 89 households, residing on the middle of the mountain slope. Mountain spring water in drainage canals is used in daily life. Rice fields and places around houses were the main transmission localities. The infection rates of inhabitants and cattle were 67.8% and 35.0%, respectively (Zheng *et al*, 1990).

3) Zhonghe Village, a highly endemic area in a plateau valley, is located at an altitude of 1,900 m to 2,100 m. The inhabitants, mainly Yi minority with together with Han, were 542 in 108 households, living on the mountain slope. No public places with high transmission potential could be found in the village. Rice fields and vegetable gardens were the main places of schistosomiasis transmission. The

infection rates of inhabitants and cattle were 48.4% and 26.9%, respectively, in 1984.

4) Tuanshan Village, a highly endemic area of schistosomiasis in a mountainous plateau, is located at an altitude of about 1,900 m. The village has plenty of irrigation canals and ditches. A total of 976 inhabitants in 137 households are mainly rice farmers; the water in wells, ditches and rivers is used in daily life, and the water in ditches is used for vegetable growing and washing stool buckets as well. In 1989, the infection rates of inhabitants and cattle were 56.3% and 12.6%, respectively. Economic reform was initiated in the above pilot villages in 1985.

Methods of investigation

Subjects: 2,596 inhabitants in 431 households in the four villages. Sex, age, average annual income per capita, education background, occupation, were recorded. Records of stool examination and case histories of inhabitants concerning schistosomiasis in the past 10 years were analyzed. Distribution of habitations, rice fields, ditches, cattle grazing lands, extent of activities of domestic animals, and spots with high transmission potential were recorded. Frequency and duration of contact with cercariae-infested water in inhabitants in areas with high transmission potential were evaluated (Kralsvig and Schutle, 1986). Kinds and amount of crops and alteration of production system were assessed.

Data on incidence and morbidity in inhabitants and domestic animals and the distribution of *Oncomelania* snail habitats were collected from local stations for schistosomiasis control and stations of veterinary medicine. Data of kinds and amount of domestic animals and economic status were obtained from local agricultural departments. Data on human behavior and animal activities were recorded in questionnaires in the course of household visits.

Quality control

The questionnaire was drafted based on a TDR design for investigation of socioeconomic factors in filariasis and other investigation methods (Herrin, 1986; Dai, 1989).

Local investigators were selected from personnel with practical experience in schistosomiasis control. They were trained to complete the questionnaires and to use the criteria of judgment correctly.

The questionnaires were checked and the reliability was assessed based on reexamination results acquired from one natural village which was selected randomly by the principal investigators.

Statistical analysis

Chi-square test of the goodness-to-fit of binomial distribution was used to detect family distribution patterns of inhabitants showing positive results in stool examinations or with history of *Schistosoma japonicum* infection in the four villages. By single- and multi-factor analysis (Jin, 1992; Sun, 1990), the effect of socioeconomic factors and human behavior on schistosomiasis transmission in different endemic areas was evaluated.

RESULTS

Family distribution of schistosomiasis cases before and after economic reform

The following points are shown in Table 1.

(1) Family clustering of inhabitants with history of *Schistosoma japonicum* infection in Bihuayuan Village and the absence of family clustering in the other three villages before economic reform.

(2) Family clustering of schistosomiasis cases occurred in Zhonghe and Bihuayuan Villages after the economic reform, while family clustering of inhabitants with schistosomiasis history did not occur in Tuanshan and Liantie Villages.

(3) Identical status was observed regarding the distribution of inhabitants showing schistosome eggs in stool examination.

Analysis on the causes of family clustering of schistosomiasis cases

Comparison of human behavior in the two endemic villages located at mountianous plateau is detailed in Table 2, which shows:

Table 1

Family distribution of schistosomiasis cases before and after economic reform in four pilot villages.

	Before economic reform		After economic reform	
	People with infection history	Positives in stool exam	People with infection history	Positives in stool exam
Zhonghe, Weishan	$x^2 = 0.95651$	$T = 1.85$	$x^2 = 10.71$	$T = 2.5$
County	$p > 0.3$	$p > 0.05$	$p < 0.02$	$p < 0.05$
Tuanshan, Weishan	$x^2 = 0.34$	-	$x^2 = 1.65$	$x^2 = 6.008778$
County	$p > 0.5$		$p > 0.3$	$p > 0.05$
Liantie, Eryuan	$x^2 = 1.65157$	-	$x^2 = 4.31$	$x^2 = 0.4394$
County	$p > 0.1$		$p > 0.05$	$p > 0.5$
Bihuayuan, Eryuan	$x^2 = 4.828$	-	$x^2 = 10.39$	$x^2 = 16.00605$
County	$p < 0.05$		$p < 0.05$	$p < 0.05$

(1) Frequency of contact with cercariae-infested water around the habitations with high transmission potential was significantly higher in Bihuayuan Village than that in Tuanshan Village.

(2) Frequency of contact with cercariae-infested water in public places with high transmission potential was significantly higher in Tuanshan Village than that in Bihuayuan Village.

Table 2

Comparison of human behavior in Tuanshan and Bihuayuan natural villages (M-W test).

Factors	Tuanshan	Bihuayuan	p-value
Laborer migration	517.9	347.1	0.0000
Frequency of contact with cercariae-infested water			
A. Localities with high transmission potential in the vicinity of household habitation			
a. Around habitations	347.6	581.5	0.0000
b. Vegetable gardens	555.8	294.9	0.0000
c. Rice fields	438.7	456.0	0.2900
B. Public places with high transmission potential			
a. Pond water	530.8	329.3	0.0000
b. Ditches and canals	514.1	396.5	0.0000
c. Rivers	584.1	256.1	0.0000
C. Water usage in daily life			
a. Ditches and canals	513.2	397.2	0.0000
b. Ponds	489.6	386.1	0.0000
Frequency of grazing			
a. Family-retained fields	463.6	421.8	0.0001
b. Oher fields	474.0	407.5	0.0000
c. Fixed places	445.2	447.1	0.8793
d. No fixed places	471.4	411.1	0.0000
Frequency of promiscuous defecation			
a. Vegetable gardens	480.2	398.9	0.0000
b. Rice fields	396.6	514.0	0.0000
c. In other environments	442.2	451.2	0.5781

(3) Status of pasturing: Except for the fixed places the three other indices in Tuanshan Village were significantly higher than those in Bihuayuan Village. It suggested that pasturing places in Tuanshan Village were not so definite, while they were comparatively definite in Bihuayuan Village.

(4) Frequency of promiscuous defecation in family-retained vegetable gardens in Tuanshan Village was higher than that in Bihuayuan Village while it was the converse case for rice fields.

(5) The proportion using ditch and pond water in daily life was significantly higher in Tuanshan Village then in Bihuayuan Village.

(6) Frequency of laborer migration in Tuanshan Village was higher than in Bihuayuan Village.

The pattern in two endemic villages in the mountainous valley was as follows (Table 3) :

(1) The frequency of laborer migration in Liantie Village was significantly higher than that in Zhonghe Village.

(2) The frequency of water-contact in places with high transmission potential such as vegetable gardens and rice fields, was higher in Zhoughe Village than that in Liantie Village.

(3) The proportion of water-contacts in ditches and ponds in Liantie Village was higher than that in Zhonghe Village.

(4) There were no fixed places for pasturing in Liantie Village, which was contrary to the situation in Zhonghe Village.

(5) The frequency of promiscuous defecation in vegetable gardens and family-retained rice fields was significantly higher in Zhonghe Village than in Liantie Village.

(6) Ditch water was commonly used in daily life in Liantie Village.

With the inhabitants with schistosomiasis history as a dependent variable, and corresponding social factors and human behavior as independent variables, the results of LOGISTIC analysis showed that:

Table 3

Comparison of human behavior in Zhonghe and Liantie natural villages (M-W test).

Factors	Zhonghe	Liantie	p-value
Laborer migration	399.1	445.2	0.0000
Frequency of contact with cercariae-infested water			
A. place with high transmission potential in the vicinity of household habitation			
a. Around habitations	237.6	551.2	0.0000
b. Vegetable gardens	474.4	303.9	0.0000
c. Rice fields	416.2	364.7	0.0000
B. Public places with high transmission potential			
a. Ponds	299.6	486.5	0.0000
b. Ditches and canals	367.0	416.1	0.0024
c. Rivers	394.9	387.0	0.2721
C. Water usage in daily life			
a. Ditches and canals	340.9	443.4	0.0000
Frequency of grazing			
a. Family-retained fields	392.2	389.8	0.8187
b. Oher fields	363.0	420.2	0.0000
c. Fixed places	415.7	365.2	0.0000
d. No fixed places	349.0	434.8	0.0000
Frequency of promiscuous defecation			
a. Vegetable gardens	459.9	319.0	0.0000
b. Rice fields	460.1	318.8	0.0000
c. Other environments	400.9	380.7	0.1776

(1) The main factors of schistosomiasis without family clustering in Tuanshan and Liantie villages were: laborer migration, water-contacts in public places with high transmission potential, use of ditch water in daily life and no fixed pasturing place.

(2) The main factors of schistosomiasis transmission with family clustering in Bihuayuan and Zhonghe villages were: working as well as promiscuous defecation in rice fields and vegetable gardens, and grazing of infected domestic animals in the family-retained fields.

DISCUSSION

Relationship between schistosomiasis transmission and human behavior and activities of domestic animals

The contamination of environment by activities of infected humans and animals, and the role of *Oncomelania* snails as the intermediate host contribute to *Schistosoma* infection in man and animals being exposed to risk environment (Mao, 1989). Therefore, schistosomiasis is in many respects a behavior-related disease, that is, human behavior is the main factor in transmission. Infection rate and infection intensity in man are largely dependent on the status of water-contact behavior as well as on the site, range and number of infested snails. Actually, the chance and intensity of infection are determined by the frequency, duration and surface area of exposure to the infested water. Factors associated with infection are complicated. The heavily infested water bodies are usually polluted severely by human and animal excreta where the density of infested snails is also very high. A comparison of the frequency of water-contact in different areas at high risk can be used to assess the relative risk in different environments. The natural environment and biological characteristics of *Schistosoma japonicum* strains are generally stable in an endemic areas, but the socioeconomic factors, the living style and customs and production system are varied considerably, which play an important role in the diversity of prevalence. And the clustering of schistosomiasis cases discloses the relationship between the behavior of a small group of persons and the infection of schistosomes (Mao, 1989).

The influence of economic reform on human behavior and activities of domestic animals

Before economic reform, there were no fixed places for promiscuous defecation, fertilizer spread and cattle grazing, because the area of a production team was taken as the site of farming activities. After economic reform, the production and living style changed greatly, that is, from large scale of collective laboring to individually worked family-retained fields. The sites for activities of family members, promiscuous defecation and fertilizer release were rather concentrated, hence the comparative focalization of environment polluted by human behavior and animal activities, with family clustering of schistosomiasis cases. If there existed infected person(s) and/or animal(s) in a family and *Oncomelania* snails in the retained fields, schistosomiasis would be transmitted in the family. Naturally, family clustering of schistosomiasis cases did not occur, provided there were neither schistosomiasis patients and cattle nor *Oncomelania* snails in the surroundings (Zheng *et al*, 1989; 1990). Under the circumstances of human behavior and animal activities such as laborer migration, high frequency of infested water-contact in public places with high jeopardy of transmission, short distance from places at risk of transmission of neighboring households and lack of definite sites of contamination, family clustering of schistosomiasis cases did not occur. It is noteworthy that the change of raising domestic animals from a collective to a family undertaking with economic reform can either constrain their activities to a limited area or result in grazing in unconfined fields. The absence of family clustering of schistosomiasis cases can also result from the exchange use of domestic animals and indefinite pasturing places. The importation and exportation of domestic animals causing reservoir migration is also one of the important factors influencing the distribution pattern of schistosomiasis cases, Zheng *et al*, 1990).

Influence of human behavior on case distribution pattern

The results of single-factor analysis on the two villages without family clustering of schistosomiasis cases show that:

(1) Laborer migration is common.

(2) The proportion of the people contacting

cercariae-infested water in public areas at high risk of transmission is significantly higher in the two villages without family clustering than that in the other two villages with family clustering.

(3) Generally, there were no fixed places for animal grazing.

(4) There were no definite places for promiscuous defecation of man and domestic animals.

Converse results were obtained in the other two villages showing family clustering of schistosomiasis cases:

(1) Frequency of infested-water contact in public places with high transmission potential was low.

(2) Relatively fixed places existed for animal grazing.

(3) Promiscuous defecation of humans occurred mainly in rice fields and vegetable gardens.

(4) Frequency of laborer migration is low.

Water in ditches around habitations and from mountainous springs was used in daily life of inhabitants in Bihuayuan and Zhonghe villages, respectively, no public places with high transmission potential existed and the laborer migration was not frequent.

Results of multi-factor analysis showed that the high frequency of infested-water contact in places with high transmission potential and laborer migration in Tuanshan and Liantie villages changed the contact pattern of cercariae-infested water. Nonexistence of fixed places for animal grazing and migration of domestic animals leads to the spread of infection sources. The coordination of the above factors resulted in the absence of family clustering of schistosomiasis cases. The different situation of Bihuayuan and Zhonghe villages resulted in family clustering of schistosomiasis cases. The conclusion is parallel to that from the single-factor analysis.

Studies of the influence of socioeconomic factors on the family-based distribution patterns of schistosomiasis cases in mountainous endemic areas have not been noted elsewhere. The consequences attained will provide a basis for planning of strategies and measures for schistosomiasis control *in situ*.

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