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A MULTIVARIATE ANALYSIS OF THE RELATIONSHIP BETWEEN WORK ABILITY AND *S. japonicum* INFECTION IN DONGTING LAKE REGION, IN CHINA

Li YUESHENG, Li YI, Yu DONBAO, Xia MENG, Hu SHENGQIN, Xiang YANG & Zhong ZHINAN

SUMMARY

A cross-sectional case-control study on the association between the reduced work ability and **S.japonicum** infection was carried out in a moderate endemic area for schistosomiasis japonica in the southern part of Dongting lake in China. A total of 120 cases with reduced work ability and 240 controls paired to the case by age, sex, occupation and without reduced work ability, participated in the study. The mean age for individuals was 37.6 years old (21-60), the ratio of male: female was 60:40, the prevalence of **S.japonicum** in the individuals was 28.3%. The results obtained in this study showed that the infection of **S.japonicum** in case and control groups was 49.2% (59/120) and 17.9% (43/240), respectively. Odds ratio for reduced work ability among those who had schistosomiasis was 4.34 (95%), confidence interval was 2.58-7.34, and among those who had **S.japonicum** infection (egg per gram > 100) was up to 12.67 (95%), confidence interval was 3.64-46.39. After odds ratio was adjusted by multiple logistic regression, it was confirmed that heavier intensity of **S.japonicum** infection and splenomegaly due to **S.japonicum** infection were the main risk factors for reduced work ability in the population studied.

KEY WORDS: Schistosomiasis japonica; Work ability; Multivariate analysis; China.

INTRODUCTION

Dongting lake region covers 32064 km^2 in the northern of Hunan province below the Yangze river. The lake is the second largest fresh water lake in China, and plays an important role in regulating the amount of water in the Yangze river. The lake region abounds in grain, cotton and fishes from the surrounding lowland. However, the region is also an important endemic area for **S.japonicum** in China. The first case infected with **S.japonicum** in China was reported from the lake region in 1905 by Logan, an American Physician. Schistosomiasis was prevalent in 24 counties and 14 state farms. A total amount of 960,000 persons and 330,000 domestic animals had been infected with this parasite in 1956. The intergrated measures against schistosomiasis were taken in 1956, since then, endemicity of **S. japonicum** infection in the lake region decreased greatly[15,18,21,23]. As the transmissive factors of **S.japonicum** in the region involved the complex synergy of humans, vector and environment, control schistosomiasis programmes were confronted with a lot of difficulties, such as people behaviours, belief system, knowledge and perception of schistosomiasis, productive water contacts, socio-economic status, limited financial resources from local government, and so on. In 1989, it was estimated that 327,000 persons were infected with **S.japonicum** in 2,306 endemic villages, with a total population of 3.15 millions in the lake region[15].

Several reports from field studies on the socio-economic and health impacts due to **S.mansoni** and **S.haematobium** have been reviewed[16,22]. The studies revealed an indirect or direct relationship between work output, productivity and individuals infected with **Schistosomes** in a defined area[2,5,7,8,13,17,20]. The differences in earnings (directly reflecting the combined effect of work days supplied and per daily work productivity) between groups of people infected and uninfected with schistosomiasis have been used for quantita-

Human Institute of Parasitic Diseases, WHO Collaborating Centre for Research and Control on Schistosomiasis in Lake Region, Yueyang, Hunan Province, 414000 The People's Republic of China
Address for correspondence: Li Yuesheng, Hunan Institute of Parasitic Diseases, Yueyang, Hunan 414000, P.R. of China.

tive assessment of the impacts due to **Schistosome** infection on the productivity of field workers. However, due to the difficulties of methodology for assessing these impacts, and the lack of successful models proposed in these studies, the information available in some studies also was controversial[2,22].

Similarly, few field research reports on the social economic impacts due to **S.japonicum** infection are available. It is well known that schistosomiasis japonica is more harmful to peoples' health than other kinds of schistosomiasis[4]. As soon as patients infected with **S.japonicum** develop into the advanced stage of this disease, showing clinical signs, such as portal hypertension, ascites, splenomegaly hypersplenism, upper gastrointestinal bleeding, hepatic coma and liver failure, the patients may lost their work ability and even die[10,11]. This study attempts to understand the possible relationship between the reduced work ability and **S.japonicum** infection in a population at an endemic area presenting moderare endemicity levels of this infection, in the Dongting lake in China.

METHODS

Studied area and population: The study is carried out at a moderate endemic area for schistosomiasis japonica, in the southern of the Dongting lake, in China. Total population in the area is about 2500, distributed into 10 villages, that are not situated in endemic area for malaria and visceral leishmaniasis. In each village, there is 2-3 person's leading group who are responsible for work organization, register outcome of the production, check absenteeism and distribution of bonus earnings to each person in the village. The houses of residents are located inside the embankment of the lake. Ninety percent of families are supplied with pipe-water. There is a clinic in the studied area, which is responsible for the health care to local people and keeps medical records of the residents in. Outside of the embankment, there is focus of transmission for **S.japonicum**. The residents are mainly engaged in agriculture production of corn and cotton. However, they often catch fishes in the lake during the fishing seasons. A recorded prevalence in 1988 was 25% (Kato-Katz technique).

Sample size: Based on the previous experience of epidemiological survey in a population given,ng that prevalence of schistosomiasis japonica in the group with reduced work ability was around 35%, and in the group without reduced workability was around 15%, the minimum sample size needed to detect a relative risk (RO) of 2, with $\alpha = .05$ and $\beta = .10$, sample size in each group was 120[14]. Matching pair was taken by a ratio 1:2 (case:control). A total of 120 cases and 240 controls were selected from the whole population in the area studied.

Case defined: Cases were defined as residents in the area, age above 21 years old, with a well established record for the last six months (having medical records of weak and fatigue in the clinic, more than 3 days ill spell/per months; productivity per month worked reduced above 10%, the amount of labour time supplied per month reduced above 10%).

Control defined: Those without records of reduced work ability in the villages were chosen as controls (in a pair, sex, occupation, and house quality and residence circumstances, and living condition of controls were as same as those of the case; ages were within the range of 2 years).

Questionaire interviewed: All individuals included in this study were interviewed, and an individual questionaire form was filled out by two special investigators. The heads were as follows: name, sex, age, place of birth, education, occupation, housing quality, earning income/half year, absenteeism/per month, medical histories/half year, water contact/per month, histories of past treatment for schistosomiasis, symptoms, and so on.

Physical examination: Individuals were examined lying on their back and on their right side for liver and spleen palpation. Liver or spleen were considered to be enlarged when the organs were palpable below the costal margin during quiet breathing.

Parasitological examination: It was used for Kato-Katz technique[9]. Three slides from a single stool amount were prepared for each individual. Each slide can be loaded with 50 mg of stool sample, total eggs detected in three slides from one person, being divided into 3, then multiplied by 20, thus, this the mean egs/per gram stool for the

subject. Every twentieth number of slides was sampled to check doubly for quality control by another microscopist.

Investigators who carried out questionaire interviewed, or physical or parasitological examinations, had no knowledge of whether the results belong to case or control individuals, as well as interviewed and laboratory results.

Statistical analysis: EpiInfo 5.0 software was used to do univariate analysis. Significance level considered was 0.05. Confidence interval (CI) of odds ratio was determined by Woolf' method. Adjusted odds ratio was calculated by multiple logistic regression model (MULTLR Microcomputer Program software), population attributable risk was calculated by Rook's[1,3]

RESULTS

1. General information and univariate analysis

A total of 360 individuals was chosen from the whole population in the area studied. Mean age was 37.6 years old (21-60). The ratio of male and female was 60:40. One hundred and twenty individuals were in case group, two hundred and forty other ones were in control group. The rate of **S.japonicum** infection for total individuals was 28.3%. Moderate intensity (eggs per gram stool > 100) of **S.japonicum** was up to 14.8% among those who were infected with **S.japonicum**. The rate of hepatomegaly and splenomegaly was 35.8% and 3.8%, respectively. Eighty-three point twenty-four percent of the individuals had been treated for schistosomiasis before this study.

Among the 12 variables, the infection rates of **S.japonicum** showed significant difference in case and control groups: 49.2% (59/120) and 17.9% (43/240), respectively. Odds ratio for reduced work ability among those who had schistosomiasis was 4.34; 95% CI was 2.58-7.34. The odds ratio was increased with heavier intensities of **S.japonicum** infection. When the intensity of **S.japonicum** infections (epg) was > 100, odds ratio for reduced work ability was up to 12.67; ninety-five percent CI was 3.46-46.39 (Table 1).

Table 1
Univariate analysis in the case and control groups

Variables	Cases (n = 120)%	Controls (n = 240)%	Odds ratio (95% CI)		P
Schistosomiasis	49.2	17.9	4.34	(2.58 - 7.34)	< 0.01
Intensity (epg)					
1 - 50	30.8	15.0	3.26	(1.89 - 5.60)	< 0.01
51 - 100	8.3	1.6	7.92	(2.40 - 16.16)	< 0.01
101 -	10.0	1.3	12.67	(3.46 - 46.39)	< 0.01
Ascaris lumbricoides	85.0	69.6	2.30	(1.23 - 4.63)	< 0.01
Trichuris trichiura	64.7	30.4	1.95	(1.20 - 3.16)	< 0.01
Fasciolopsis busik	1.7	1.3	1.31	(0.40 - 3.51)	NS*
Diarrhoea	26.7	12.5	2.49	(1.37 - 4.54)	< 0.01
Blood stool	10.8	3.8	3.05	(1.17 - 8.10)	< 0.02
Hepatomegaly	52.5	27.5	2.58	(1.75 - 4.64)	< 0.01
Splenomegaly	9.2	1.3	7.81	(1.95 - 36.47)	< 0.01
Past treatment	88.3	77.9	2.01	(1.00 - 4.10)	NS*
Water contact	90.0	70.4	3.72	(1.80 - 7.84)	< 0.01
1-5 times	26.7	50.8	2.24	(1.05 - 4.79)	< 0.05
6-	63.3	19.6	5.01	(2.53 - 10.46)	< 0.01
Income (RMB)**					
0 - 500	19.2	21.7	1.38	(0.68 - 2.79)	NS*
501 -1000	64.2	48.0	2.16	(1.21 - 3.84)	< 0.01
1001 -	16.7	30.0	3.24	(1.83 - 4.63)	< 0.01

**Income (RMB): 100 (RMB) = 25 (USY)
* No significant difference (P > 0.05)

Splenomegaly in the case and control groups was 9.2% and 1.3%, respectively. Splenomegaly due to **S.japonicum** infection showed a strong association with reduced work ability. Odds ratio for reduced work ability among those who had splenomegaly was 7.81; ninety-five percent CI was 1.95-36.47.

Most of variables studied in case and control groups showed differences at significant level ($P < 0.05$), as well as a close relationship to the reduced work ability except the variables of Fasciolopsis, past treatment and lower earning group (Table 1).

The accuracy of stool examination in a total of 110 slides was 99.01% by a quality control test. There was no false positive, however, the false negative was 5.88% (1/17) in the quality control. It was showed that quality of stool examination in this study was satisfactory.

2. Adjusted odds ratios in multiple logistic regression method

Removing the effect of confounding variables in a study is more important to assess accurately odds ratios of variables. The individuals selected in the study were taken by macthing pairs, some potential confounding variables, for example, age, sex and occupation which have been shown to be associated to **S.japonicum** infection, were removed. We used the multivariate logistic regression to assess the independent effects of variables and calculated the adjusted odds ratios by multiple logistic regression methods (all variables in the table were included in the final model). The results showed that heavier intensity of **S.japonicum** infection and splenomegaly due to **S.japonicum** infection were of higher adjusted odds ratios, and showed also a very strong relationship between the two variables and reduced work ability in the individuals studied (Table 2).

Table 2
The adjusted odds ratios by multivariate analysis

Variables	Adjusted odds ratio (95% CI)*
Schistosomiasis	3.24 (1.89 - 5.54)
Intensity (epg)	
1-50	2.27 (1.24 - 4.15)
51-100	7.42 (2.67 - 31.22)
101-	9.78 (1.92 - 33.48)
Hepatomegaly	1.76 (1.02 - 3.04)
Splenomegaly	8.12 (1.83 - 36.04)
Trichuris	2.18 (1.30 - 3.67)
Diarrhoea	2.09 (1.13 - 3.87
Water contact	
1-5 times/month	1.68 (0.73 - 3.89)
6- times/month	3.15 (1.42 - 7.02)

* Adjusted by multiple logistic regression methods (all variables in the table were included in the final model)

3. Population attributable risk for the reduced work ability

In order to estimate the effects of risk factors for reduced work ability in the population, the indexes of population attributable risk of variables were measured. The results showed that among all risk factors studied, the **S.japonicum** infection was the greatest factor for population attributable risk in reduced work ability (Table 3).

Table 3
Population attributable risk for reduced work ability on initial examination

Risk factor at initial examination	Adjusted odds ratio (OR)	Proportion of population (P)%	Population atrributable risk (PAR)*
Schistosomiasis	3.24	28.98	0.39
Trichuris	2.18	36.65	0.26
Diarrhoea	2.09	21.39	0.18
Hepatomegaly	1.76	36.64	0.22
Splenomegaly	8.12	3.98	0.22
Water contact			
1-5 times/month	1.68	32.67	0.18
6- times/month	3.15	23.57	0.34

* PAR = P (OR - 1)/[1 + P (OR - 1)]

DISCUSSION

As early as in 1967, FOSTER reported that **Schistosome** infection led to an increase of the proportion of individuals seeking for medical treatment, and absenteeism was also higher in the infected individuals although no difference could be detected in the output of sugar cane in infected and uninfected workers[8]. FENWICK & FIGENSCHOU (1972) retrospectively examined the bonus earnings of cane cutters and compared the earnings between infected and uninfected groups. They found that mean bonus earnings of uninfected field workers were higher than that of infected field workers. Longitudinal analysis of the study was reinforced by the demonstration that infected individuals who underwent chemotherapy showed dramatic improvement[7]. BARBOSA & PEREIRA (1981) reported that the results of work capacity effects in a retrospective study were not conclusive, but clear-cut results emerged from a prospective study. They found that cane cutters with splenomegaly due to **S. mansoni** had an average of 35.1% less productivity than those having intestinal form of schistosomiasis mansoni[2]. However, VAN & POLDERMAN (1984) reported that working capacity between **S.mansoni** infected and uninfected male labourers showed no significant difference in a tin mine population in Zaire[17]. In view of the difficulties of assessing the social economic and health impacts of any disease, although the available data from these studies are highly variable in terms of objectives, methods, study area, type and levels of infection, their results give some indication that persons with high intensities of infection will have some reduction in their work capacities[2,22].

The available data on socio-economic consequences due to **S.japonicum** infection, are very limited. OLVEDA et al. (1983) reported symptoms of inability to work in persons infected with **S.japonicum** during the previous 2 weeks in lower prevalence village A and higher prevalence village C were 13% and 25%, respectively, on the other hand, the symptoms of inability to work in uninfected persons in the two villages were 0% and 7%, respectively[13]. WARREN et al. (1983) also reported, in a study of rural brigades in Anhui province, China, that symptoms to inability work in the infected and uninfected persons were 10% and 1%, respectively. They pointed out that sym-

ptoms of inability to work occurred when the patients were heavily infected with **S.japonicum** (EPG > 400)[19]. These studies revealed the impacts due to **S.japonicum** infection on a person's work ability. We have adopted a group of well-defined cases with the reduced work ability in a population, in order to explore what is the main cause and what is the greatest risk factor for case group. The results have confirmed infection and heavier intensities of **S.japonicum** infection, splenomegaly and high frequency of water contact were the main risk factors for the reduced work ability in local population. By multiple logistic regression methods, it has been showed the independent effects of these variables to reduce work ability. In our previous study[22], we reported that earnings/year in persons infected with **S.japonicum** were 18.5% lower than that in persons uninfected with **S.japonicum**. In this study we found there was no significant difference in earning groups adjusted by multivariate analysis.

Schistosomiasis is a behavioural disease, it is caused by people, not by snails[6,12,17,22]. Our previous studies have showed that human behaviours plays a very important role in the occurence of infection with **S.japonicum**[21,23]. Although 90% of families in the area studied have been supplied with piping water system, frequency of contacting water in production and leisure activity is also high. It is necessary to undertake more well-desiged social epidemiological studies, based on the experience of social epidemiological studies, to adopt pragmatic approaches to encourage people to alter the mode and patterns of production, in the meantime, to strengthen health education for making people themselves to realize the gravity of schistosomiasis and to change behaviours themselves. After only these measures are taken, the programme of controlling schistosomiasis can be successfully carried out and sustained in an endemic area for **S.japonicum**.

RESUMO

Análise multivariada da relação entre capacidade de trabalho e infecção por *S.japonicum* na região dos lagos de Dongting, China.

Um estudo seccional de casos controles da associação entre a capacidade reduzida para o trabalho e a infecção por **S.japonicum** foi levada a efeito em região moderadamente endêmica para esquistossomose japônica na parte sul do lago Dongting, China. Um total de 120 casos com redução da capacidade de trabalho e 240 controles pareados no que diz respeito a idade, sexo, ocupação sem redução da capacidade de trabalho. A idade média dos pacientes foi 37,6 anos (21-60) e a relação masculino:feminino foi 60:40. A prevalência do **S.japonicum** foi de 28,3%. Os resultados obtidos neste estudo mostraram que a infecção nos casos e no grupo controle foi 49,2% (59/120) e 17,9% (43/240) respectivamente. A média para redução da capacidade de trabalho entre aqueles com esquistossomose foi 4,34 (95%) e o intervalo de confiança foi 2,58-7,34 e entre aqueles com infecção por **S.japonicum** (ovo por grama > 100) foi de 12,67 (95%), com intervalo de confiança de 3,64-46,39. Depois que a média foi ajustada através de regressão logística múltipla, foi confirmado que a maior intensidade de infecção pelo **S.japonicum** e a esplenomegalia eram os fatores principais de risco para a reduzida capacidade de trabalho da população estudada.

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