

Assessment of Knowledge, Attitude and Practices and the analysis of Risk Factors regarding Schistosomiasis Among Fishermen and Boatmen in Dongting Lake Basin, P.R. China

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Research

Keywords: Schistosomiasis; Knowledge; Attitude; Practice; Prevalence; Influence factors; Logistic regression

Posted Date: December 27th, 2019

DOI: <https://doi.org/10.21203/rs.2.18362/v2>

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Version of Record: A version of this preprint was published at Parasites & Vectors on June 1st, 2020. See the published version at <https://doi.org/10.1186/s13071-020-04157-4>.

Abstract

Background: Fishermen and boatmen are a risk population for contracting schistosomiasis due to their high frequency of water contact in endemic areas of schistosomiasis in the People's Republic of China (P. R. China). To develop specific interventions towards this population, our present study was designed to assess the knowledge, attitudes and practices (KAPs) towards schistosomiasis of fishermen and boatmen, and to identify the risk factors associated with schistosome infection using molecular technique in the selected area. **Methods:** A cross sectional survey was conducted in the Dongting Lake Basin of Yueyang County, Hunan Province, P. R. China. A total of 601 fishermen and boatmen were interviewed from October to November in 2017. Information regarding socio-demographic details and knowledge, attitude, and practices toward schistosomiasis were collected using a standardized questionnaire. Fecal samples of participants were collected and tested by Polymerase Chain Reaction (PCR), and logistic regression analysis was conducted to explore the risk factors related to the positive results of PCR. **Results:** Of the 601 interviewed participants, over 90% of respondents knew of schistosomiasis and how the disease was contracted, the intermediate host of schistosomes and preventive methods. The majority of respondents had a positive attitude towards schistosomiasis prevention. However, only 6.66% (40/601) of respondents had installed a latrine on their boats, while 32.61% (196/601) of respondents defecated in the public toilets on shore. In addition, only 4.99% (30/601) respondents protected themselves while exposed to freshwater. The incidence of schistosomiasis, as determined by PCR, among fishermen and boatmen in Yueyang County was 13.81% (83/601). Age, years of performing the current job, number of times receiving treatment, and whether they were treated in recent three years were the main influencing factors of PCR results among this population. **Conclusions:** Fishermen and boatmen are still at high risk of infection in China and gaps exist in knowledge, attitude and practices toward schistosomiasis in this population group. Chemotherapy, and health education encouraging behavior change in combination with other integrated approaches to decrease the transmission risk in environments should be improved.

Introduction

Schistosomiasis has been considered to be one of neglected tropical diseases of public health importance in tropical and subtropical areas of the world [1-3]. It is endemic in 78 countries and territories globally with 250 million people infected [4]. The People's Republic of China (P.R. China) used to have the highest disease burden of schistosomiasis caused by infection with *Schistosoma japonicum*. According to the national survey conducted in 1950s, there were estimated to be 11.60 million human cases and one million infected cattle [5]. Schistosomiasis is acquired when people or domestic animals contact freshwater contaminated with free swimming cercariae of schistosomes.

During the past seven decades, great efforts have been made to control schistosomiasis through consecutive and vertical control programs by the Chinese government. This is especially true over the past decade when preventing schistosomiasis ranked as a high priority among four important infectious diseases nationally, including HIV/AIDS, tuberculosis and hepatitis B [6]. During that time an integrated

control strategy was also implemented for schistosomiasis according to the medium- and long-term national control plan [7-9]. The prevalence and intensity of infections with *S. japonicum* in humans has been reduced substantially, and the number of endemic provinces has decreased from 12 to seven [10, 11]. Currently schistosomiasis is mainly endemic in areas surrounding Dongting Lake, Poyang Lake and beaches along the Yangtze River [12-15], with fishermen, boatmen and farmers being groups at high risk of infection and suffering the highest disease burden [16].

In spite of the great success in schistosomiasis control in P.R. China as a result of these programs, there are still enormous difficulties and challenges surrounding transmission interruption and the elimination of schistosomiasis [17]. Potential risk factors for the resurgence of schistosomiasis still exists and the prevalence of schistosomiasis can rapidly rebound in the lake and marshland region due to its unique environment [18]. Tools used to determine the infection status or prevalence of schistosomiasis in humans are still heavily reliant on traditional methods, such as Kato-Katz, which presents the increasingly obvious disadvantage of poor sensitivity, especially in low endemic situations of mild infection [19, 20]. The false negative result could eventually contribute to inappropriate decisions being made by the government. According to the national surveillance data, floating populations, and in particular, fishermen and boatmen, are becoming increasingly significant in schistosomiasis transmission [21]. Reinfection with *S. japonicum* among fishermen and boatmen is still a key issue impeding the transmission interruption or elimination of schistosomiasis in the lake and marshland regions in China [16].

Adequate knowledge, positive attitudes and the correct preventive practices of populations towards schistosomiasis prevention and control in endemic regions can provide an effective sustainable environment for the success and sustainability of schistosomiasis control [22-24]. Although health education is an important approach for schistosomiasis intervention, information on the current infection status and KAPs on schistosomiasis among fishermen and boatmen remains unclear. This study aimed to assess the KAPs towards schistosomiasis among fishermen and boatmen in selected areas. Infectious status and its influential factors were also identified in this population.

Methods

Study Design

This study was a cross-sectional survey that assessed the knowledge, attitude and practices (KAPs) on schistosomiasis, evaluated the prevalence of schistosomiasis and its risk factors among fishermen and boatmen in the study area.

Study Area and Population

The study was carried out from October to November in 2017 in Yueyang county, Hunan province, which is located on the eastern bank of Dongting Lake in southern China (Fig. 1). Two villages, Lujiao and

Matang, in this county were sampled in random by stratified clustered sampling, in which the prevalence and villages were viewed as a stratum and clustering, respectively. As a typical lake and marshland endemic area of schistosomiasis, there were numerous fishermen and boatmen who were considered to be the most at-risk group of *S. japonicum* infection. Fishermen and boatmen in this region commonly live or work on ships for at least four months per year, and their economic income mainly comes from fishing and goods transportation. The study population was comprised of either the professional fishermen and boatmen, or the sidelines. All participants involved had not received any anti-schistosome treatment within a period of six months before the study. The interviews were conducted when their ships berthed in docking spots of Lujiao and Matang in Yueyang County, Hunan Province, P. R. China.

Questionnaire Survey

A pretested semi-structured questionnaire was developed after performing a thorough literature review of comparable studies [22, 25-28], to assess the KAPs of participants towards schistosomiasis prevention. This survey was conducted by well-trained interviewers and was monitored by quality control supervisors who were arranged for each group before the interviews. The questionnaire consisted of four main sections. The first part covered socio-demographic information such as age, gender, education, family income, water-contacting frequency, history of receiving schistosomiasis examination and treatment. The second chapter examined participants' knowledge of schistosomiasis, including the transmission season, susceptible population, definitive host, transmission mode, intermediate host, clinical manifestations, impacts on children and females, preventive methods, and anti-schistosome medication. The third component assessed participants' attitudes towards schistosomiasis prevention. The last section interviewed participants' practices on schistosomiasis prevention. The full questionnaire can be found in the online [Supplementary Table S1](#).

Prevalence Survey and Laboratory Investigations

Feces from each participant were collected using a specific container, coded by unique identifiers and transferred to a laboratory in a local schistosomiasis control station. Each sample had two grams removed and placed in a cryopreservation tube at -20°C for DNA extraction. After all the samples had been pretreated, DNA of *S. japonicum* was extracted from fecal specimens according to the steps of the DNA extraction kit (QIAGEN, Germany).

Genomic DNA extracted from fecal samples was subjected to PCR using 18S-FW (5'-TTCCG ATAAC GAACG AGAC-3') and 18S-RV (5'-AGCGA TAAAG CCACT ACAAC-3') specific primers amplifying a 469 bp region of the *S. japonicum* 18S-rRNA gene [29]. PCR was carried out in a final volume of 50.0 µl, containing: 2.0 µl of template DNA, 25.0 µl of dNTPs mix (TIANGEN BIOTECH Co., Ltd, BEIJING), 1.0 µl of

upstream and downstream primers, and 21.0 µl of sterile double distilled water. The PCR conditions were as follows: 5 min at 94 °C (initial denaturation), 30 cycles of 20s at 94 °C, 30s at 56°C, 40s at 72°C, and finally 5 min at 72°C (final extension). Negative control (sterile double distilled water) and positive control (worm body tissues DNA) were set up in each batch of experiments. The PCR products were separated on 1.50% agarose gels. All of the positive PCR amplification products for 18s RNA were sequenced, and Blast comparison analyses were used to check the consistency with the targeted 18S-rRNA sequence.

Data Management and Statistical Analysis

Data collected were entered into a database using EpiData Version 3.0 and then analyzed using SAS Version 9.4 (Statistical Analysis System, RTI, Cary, North Carolina, USA). The analysis consisted of three parts. Firstly, descriptive statistics were used for the demographic characteristics of the respondents. Secondly, schistosomiasis control knowledge rates, positive attitude rates, and correct behavior rates were calculated in order to inform the KAPs of *S. japonicum* among study participants. Finally, the *Schistosoma* nucleic acid positive rate was calculated according to the results of PCR amplification and electrophoresis. Risk factors related to the positive results of PCR were analyzed by univariate logistic regression followed by stepwise regression and multivariate logistic regression model. *P*-values less than 0.05 were considered statistically significant.

Results

Socio-Demographic Characteristics

A total of 753 fishermen and boatmen were enrolled in this cross-sectional study. However, 122 people provided none or insufficient amounts of stool to prepare for PCR and 30 individuals had no or incomplete questionnaire data. Therefore, 601 individuals who completed the questionnaire and provided qualified stool samples were included in the final analysis. The socio-demographic characteristics of the respondents are presented in Table 1. The number of males was 345 (57.40%) and females was 256 (42.60%). The mean age of respondents was 50.04 years old (Standard Deviation, ±10.97). A total of 59.90% (360/601) of respondents were sideline fishermen and boatmen, while 38.27% (230/601) were professional boatmen. The majority (63.39%, 381/601) had been in their current jobs for 10 to 29 years, followed by those who have had their job for more than 30 years (128/601, 21.30%). Over 95% of respondents (576/601) had received treatment against schistosomiasis at least once.

Participants' KAPs toward Schistosomiasis

Awareness of Schistosomiasis Knowledge

Of the 601 respondents, 74.88% (450/601) knew that the susceptible season for infection with *S. japonicum* was from April to October and 72.05% (433/601) knew that all the populations were susceptible for infection of schistosomes. The majority (95.67%, 575/601) of fishermen and boatmen mentioned snails as the intermediate host of *S. japonicum* while 75.04% (451/601) of them knew the final host of *S. japonicum*. Of those surveyed, 97.00% (583/601) mentioned contacting with *S. japonicum*-infested water was the way to get infection of schistosomes. In terms of their knowledge of the symptoms and effects of schistosomiasis, 86.69% (521/601) of study respondents mentioned fever and diarrhea to be the main symptoms of schistosomiasis, while 58.40% (351/601) knew that schistosomiasis would have severe impacts on females, and 62.7% (377/601) indicated that schistosomiasis could limit children's physical growth. With respect to preventive activities and treatment for schistosomiasis, 96.17% (578/601) of interviewed fishermen and boatmen mentioned avoiding contact with *S. japonicum*-infested water as an effective preventive measure. Only 47.92% (288/601) of study participants mentioned praziquantel as an anti-schistosome drug (Table 2).

Attitude to Schistosomiasis Prevention and Control

Most respondents (95.34%, 573/601) indicated that they were willing to install feces containers on their boats. Of the 28 participants who refused to install feces containers, 57.14% complained that fishing boats were too small to accommodate it. With regard to visiting onshore public toilets, 96.17% (578/601) reported that they would like to use onshore public toilets, while 72.7% of respondents who were reluctant to use onshore public toilets gave the reason that it was inconvenient to go ashore to find toilets over such a long distance when they were working in the middle of the lake. The majority of study respondents (98.50%, 592/601) were willing to accept examination for schistosomiasis and if diagnosed as positives, 98.50% (592/601) of the study participants expressed a willingness to take medicine regularly following doctors' prescriptions. Of those surveyed, 89.85% (540/601) believed this disease could be prevented, while 71.88% (432/601) understood schistosomiasis could be cured (Table 3).

Practices of the Study Participants towards Schistosomiasis

Of the 601 respondents, only 6.66% installed and used fecal containers in the correct way. In terms of protective behaviors when contacting *S. japonicum* infested water, only 4.99% (30/601) of the respondents reported always wearing rubber shoes, gloves, protective clothing or ointment. Being too troublesome was the main reason mentioned by 83.98% (471/561) of those not always protecting themselves when contacting freshwater in Dongting Lake. Only 32.61% (196/601) of the participants reported always defecating in onshore public toilets (Table 3).

S. japonicum Infection Status and Related Risk Factors

Among 601 participants who provided qualified stool samples, 13.81% (83/601) were detected as positive by PCR. The PCR amplification products of all the positive samples were sequenced and the results showed that the DNA fragment was 469 bp, which was consistent with the target DNA both in length and sequence (Fig 2). The positive rate of *Schistosoma* nucleic acid in males (14.78%) was higher than that of females (12.50%), but no statistical difference was detected ($\chi^2=0.643$, $p=0.423$). The subgroup of participants who were aged less than 30 years old, performing their current job for more than 30 years, never been treated for schistosomiasis, or not received treatment during 2015-2017 presented the highest PCR positive rates of 38.10%(8/21), 21.09% (27/128), 32.00% (8/25) when conducting strata analysis (Table 4).

Based on univariate logistic regression analysis, nine independent variables were included in the multivariate logistic regression, including age, occupation, economic conditions, years of doing current job, infection history, diagnostic method, disease category, times received treatment, and whether received anti-schistosome treatment from 2015-2017.

The results of multivariate logistic regression analysis indicated that respondents aged 40-49, 50-59 and ≥ 60 years had significantly lower odds of being positive than younger groups (<30, 30-39), as determined by PCR ($OR_{40-49}=0.163$, 95%CI: 0.041-0.644; $OR_{50-59}=0.058$, 95%CI: 0.014-0.239; $OR_{\geq 60}=0.012$, 95%CI: 0.002-0.065). The fishermen and boatmen who had performed their current job for 10 to 29 years and over 30 years were more likely to be PCR positives, with an $OR_{10-29} = 4.162$ (95%CI: 1.461-11.856), $OR_{\geq 30} = 18.684$ (95%CI: 5.430-64.295), respectively (Table 4). In addition, the respondents who received treatment six to 10 times, or more than 10 times showed lower odds of presenting positive PCR results ($OR_{6-9} = 0.156$ (95%CI: 0.035-0.689), $OR_{\geq 10} = 0.100$ (95%CI: 0.021-0.476)), compared to those never receiving treatment for schistosomiasis. Respondents who received treatment from 2015 to 2017 were more likely to have negative PCR results ($OR = 0.479$, 95% CI: 0.246-0.930) (Table 4).

Discussion

In this study, the KAPs survey was conducted to explore the level of KAPs of fishermen and boatmen on schistosomiasis in Yueyang County of Hunan Province, P. R. China. The infection status of schistosomiasis in this special group was determined by a sensitive method based on nucleic acid detection. The risk factors related to infection were identified through logistic regression models. This study aimed to provide information for the design and development of an integrated control strategy against schistosomiasis in China.

The study showed that the overall awareness of schistosomiasis control knowledge among study participants was satisfactory, which was attributed to the persistent health education conducted for many years [30-32]. More than 90% respondents knew the cause of infection, intermediate host of schistosomes and preventive methods, while most of the respondents knew the disease, its clinical manifestations and transmission mode. However, less than 70% of respondents knew the medication against schistosomiasis or the disease impacts on children and females. It was also found that the majority of the respondents had positive attitudes towards schistosomiasis prevention. More than 95% of respondents were willing to install feces containers on their boats, use onshore public toilets, and take medicine against schistosomiasis, which would facilitate the control of schistosomiasis in this population. Nearly 90% of participants believed that schistosomiasis was preventable and 71.88% of respondents trusted that schistosomiasis could be cured.

Despite sufficient knowledge and good attitudes towards schistosomiasis prevention, the behavioral practices of fishermen and boatmen were quite unsatisfactory. People preferred to receive examinations and treatment, rather than prevent disease altogether. Only 6.66% of respondents had installed latrines on their boats and only 32.61% of respondents defecated in the onshore public toilets. There were many reasons for such findings given by the interviewed fishermen and boatmen, including the boat size and stools could overflow from containers because of boat instability, or that fecal odors could make such containers intolerable on board. Of the respondents, only 4.99% protected themselves when contacting freshwater, and the main concern of such respondents was that it was troublesome and inconvenient to wear protection apparatus when fishing or working on the water. Adequate knowledge and positive attitudes did not convert to effective behavior changes, mainly due to the strong economic drive of their work, which agreed with previous studies [22, 33]. The gaps observed between knowledge, attitude and practices indicated that effective methods and enormous efforts should be made to better address the problem of transmission caused by behavior approaches. First, appropriate health promotion activities should be provided to this high risk population. Second, existing interventions should be improved or modified to be more accessible and attractive to fishermen and boatmen. Finally, integrated approaches to eliminate the transmission risk of schistosomiasis in freshwater areas should be further explored and strengthened [14]. The prohibition of fishing activities is going to be implemented along the Yangtze River, which can assist the current situation. An effective monitoring system needs to be established and run efficiently to guarantee this policy.

In P. R. China, a two-step detection pattern with serological screening first, followed by stool examinations for serological positives is used for the field diagnosis of schistosomiasis in China [16]. This method presented great advantages in earlier programs because of its enormous capacity for large scale screening and examination. However, with the persistent implementation of integrated control strategies for schistosomiasis, the prevalence and intensity of schistosomiasis in China has reached a historically low level [20, 34]. The infected fishermen and boatmen can be easily misdiagnosed by traditional methods, such as the Kato-Katz method or miracidia hatching technique, and therefore, are not targeted for medication, which brings great challenge to the elimination of schistosomiasis in China [35, 36].

As a classic nucleic acid amplification technique, PCR has many advantages over stool examinations, such as higher sensitivity and specificity, the low cost of reagents, and the availability of universal equipment in laboratories, which will facilitate schistosomiasis detection in the future [37]. It was reported that only 2.16 eggs per gram of feces were required to detect schistosomiasis by PCR [37].

This study found a high burden of schistosomiasis in fishermen and boatmen in Yueyang County using PCR (13.81%), which is higher than the average prevalence obtained from the national surveillance system [16, 22, 38]. The following considerations are therefore initiated for discussion. Firstly, the study population generally spend most of their lives onboard and are in frequent contact with *S. japonicum* infested water, which is thought to be the main reason for their vulnerability to infection and re-infection by schistosomes [36, 39]. Secondly, interventions against schistosomiasis were not easy to cover all fishermen and boatmen due to their high mobility [25, 40]. Among the 601 respondents in our research, 4.16% had never received treatment and 36.61% had only received treatment two years before our study. Thirdly, our study used a nucleic acid-based detection method rather than traditional methods. The PCR technique used in this article had an excellent sensitivity as it could detect 10 pg/ μ l of schistosome genomic DNA (based on internal assessments), as well as great specificity reflected by DNA sequencing of the PCR products. Therefore, PCR could facilitate the diagnosis and treatment of individuals with low-level infections and assist in the elimination of schistosomiasis in P. R. China.

Logistic regression analyses showed that four variables, including age, years of performing the current job, times received treatments in history, and whether received treatments in recent three years two years were significantly associated with the PCR results. Younger fishermen and boatmen are more likely to be infected by schistosomes, which is similar to results of previous research [25]. As the main labor forces of their families, young fishermen and boatmen are more likely to be involved in fishing or household chores, which means higher frequency and greater level of exposure to *S. japonicum*-infested water; therefore, increasing the likelihood for infection. In addition, there are also studies showing that aged fishermen and boatmen with long-term exposure to water can produce an acquired immunity towards *Schistosoma*, which protects them to a certain degree [6]. Using PCR, it was found that the number of years performing the current job was positively correlated with the infection of *S. japonicum*. Study findings showed that the prevalence decreased significantly with increasing treatment times among this population. The respondents who have never been treated and those who had only been treated one to five times presented positive rates of 32.00% and 17.13%, respectively. Prevalence was higher in the participant subgroup that did not receive any treatment in the last two years. These results all indicated that PZQ treatment is still an effective way to control schistosomiasis among this population, so as to promote the elimination of schistosomiasis in P.R. China [26].

One of the limitations of this study is that 152 fishermen and boatmen were excluded from the final analysis due to incomplete response on the questionnaire or lack of stool samples for PCR test. This might has impact on the study's results. On the other side, such phenomenon reflected the difficulties of conducting control or prevention activities in low endemic areas after many years of intervention. To eliminate schistosomiasis, new approaches should be considered and explored how to improve the

coverage rate of control activities on risk population and increase their compliance to ensure the effectiveness of intervention activities.

Conclusions

Our findings show that fishermen and boatmen remain the most vulnerable population for schistosome infection in endemic areas, and are an enormous obstacle in elimination of schistosomiasis in P. R. China. Among this population, younger fishermen and boatmen with longer occupational histories, as well as those with fewer treatments, particularly in the last three years, are at increased risk of acquiring infection. In addition, gaps exist in this population between knowledge, attitude and practices towards schistosomiasis prevention. Thus, it is suggested that enhanced medication, health promotion activities encouraging behavioral changes and other integrated approaches should be combined and strengthened to reduce the incidence of schistosomiasis amongst this high-risk population.

Abbreviations

P. R. China: People's Republic of China; KAPs: knowledge, attitude and practices; PCR: Polymerase Chain Reaction; NTDs: neglected tropical diseases; OR: odd ratio; 95%CI: 95% confidence interval.

Declarations

Ethics approval and consent to participate

Ethical clearance had been granted by the Ethics Committee of the National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention in Shanghai, P.R. China (20170717). During these meetings, the objectives of the study, the study procedures, sampling, study benefits, and potential risks and discomforts were orally explained and informed to all participants. All adult participants gave informed consent, and informed consent for all children who participated in the study was sought from parents or legal guardians. Assent was sought from all participants who were also informed of their rights to refuse to participate in this study and to withdraw from the study at any time. Participants with positive PCR results received free treatments with a standard dose of praziquantel.

Consent for publication

Not applicable.

Availability of data and materials

All relevant data are contained within the paper and its additional files.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was financially supported by the National Special Science and Technology Project for Major Infectious Diseases of China (No. 2018ZX10101002-002, 2012ZX10004-220) and The National Key Research and Development Program of China (2016YFC1202000).

Authors' Contributions

Conceptualization: JX, SL, SZL. Field investigation and sample examination: ZG, JZ, X-B R, S-M D, Y-L L, Z-Q Q. Supervision: JX, S-Z L, SL, X-N Z. Writing-original draft: ZG, S-M D, JX. Writing-review & editing: JX. All authors read and approved the final manuscript.

Conceived and designed experiments: JX. Performed the experiments: ZG SMD. Analyzed the data: ZG. Wrote the paper: ZG SMD.

Acknowledgments

The authors would like to acknowledge the technicians of schistosomiasis control station of Yueyang County, who provided invaluable assistance with data collection and stool samples' collection. We are grateful to the schistosomiasis control institute of Hunan province, for permission and support.

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Tables

Table 1 Major socio-demographic characteristics of respondents attending KAPs survey and provided stool samples

Variables	Category	Frequency	Percentage (%)
Gender	male	345	57.40
	female	256	42.60
Occupation	Professional fisherman	11	1.83
	Professional boatman	230	38.27
	sideline fisherman and boatman	360	59.90
Age group (years)	<30	21	3.49
	30~	54	8.99
	40~	228	37.94
	50~	184	30.62
Education	60~	114	18.97
	Below primary school	57	9.48
	Primary school	167	27.79
	Junior middle school	324	53.91
	High school and higher education	53	8.82

Table 2 Knowledge of schistosomiasis among respondents

Knowledge regarding schistosomiasis	Response	Frequency	Percentage (%)
Transmission season	Right	450	74.88
	Wrong	151	25.12
Susceptible population	Right	433	72.05
	Wrong	168	27.95
Final host	Right	451	75.04
	Wrong	150	24.96
Intermediate host	Right	575	95.67
	Wrong	26	4.33
Cause of infection	Right	583	97.00
	Wrong	18	3.00
Main symptoms	Right	521	86.69
	Wrong	80	13.31
Effects on children	Right	377	62.73
	Wrong	224	37.27
Effects on women	Right	351	58.40
	Wrong	250	41.60
Preventive measures	Right	578	96.17
	Wrong	23	3.83
Medicine used for treatment	Right	288	47.92
	Wrong	313	52.08

Table 3 Attitude and practices toward schistosomiasis prevention and control among the study participants

Attitude and practices toward schistosomiasis	Category	Frequency	Percentage (%)
Willingness to install feces containers	Yes	573	95.34
	No	28	4.66
Willingness to use onshore public toilets	Yes	578	96.17
	No	23	3.83
Willingness to accept examination	Yes	592	98.50
	No	9	1.50
Willingness to take medicine	Yes	592	98.50
	No	9	1.50
Belief that schistosomiasis could be prevented	Yes	540	89.85
	No	61	10.15
Belief that schistosomiasis could be cured	Yes	432	71.88
	No	169	28.12
Install and use fecal containers	Yes	40	6.66
	No	561	93.34
Defecate in public toilets onshore	Yes	196	32.61
	No	405	67.39
Protection when contacted water	Yes	30	4.99
	No	571	95.01

Table 4 Multiple logistic regression analysis of variables associated with *S. japonica* among study participants

Risk factors	Positive rate determined by PCR (No. positives/No. examined)	OR (95%CI)
Age group (years)		
<30	38.10% (8/21)	1
30-39	27.78% (15/54)	0.318 (0.075-1.354), P=0.1212
40-49	15.35% (35/228)	0.163 (0.041-0.644), P=0.0096*
50-59	10.33% (19/203)	0.058 (0.014-0.239), P<.0001*
≥60	5.26% (6/114)	0.012 (0.002-0.065), P<.0001*
Years of doing current job		
<10	7.61% (7/92)	1
10-29	12.86% (49/381)	4.162 (1.461-11.856), P=0.0076*
≥30	21.09% (27/128)	18.684 (5.430-64.295), P<.0001*
Treatment times		
0	32.00% (8/25)	1
1-5	17.13% (37/216)	0.265 (0.064-1.095), P=0.0666
6-9	12.26% (26/212)	0.156 (0.035-0.689), P=0.0142*
≥10	8.11% (12/148)	0.100 (0.021-0.476), P=0.0038*
Treatment in 2015-2017		
No	18.18 % (40/220)	1
Yes	11.29% (43/381)	0.479 (0.246-0.930), P=0.0298*

OR, odds ratio. CI, Confidence interval. *Significant association (P<0.05)

Supplementary File Legends

Table S1 Questionnaire of socio-demographic data and KAPs for fishermen and boatmen

Figures

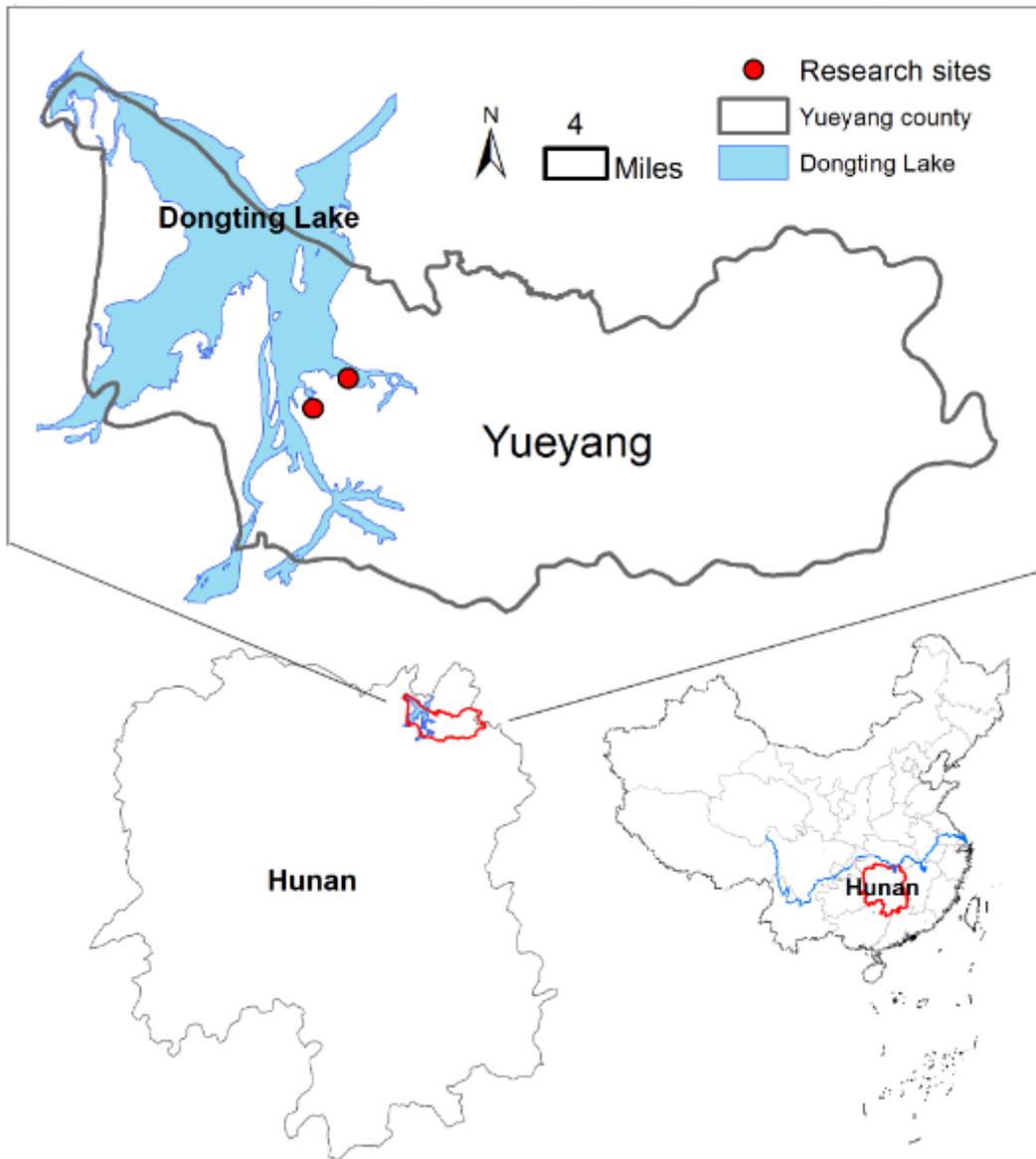


Figure 1

Location of Study Area in Yueyang County, Hunan Province. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

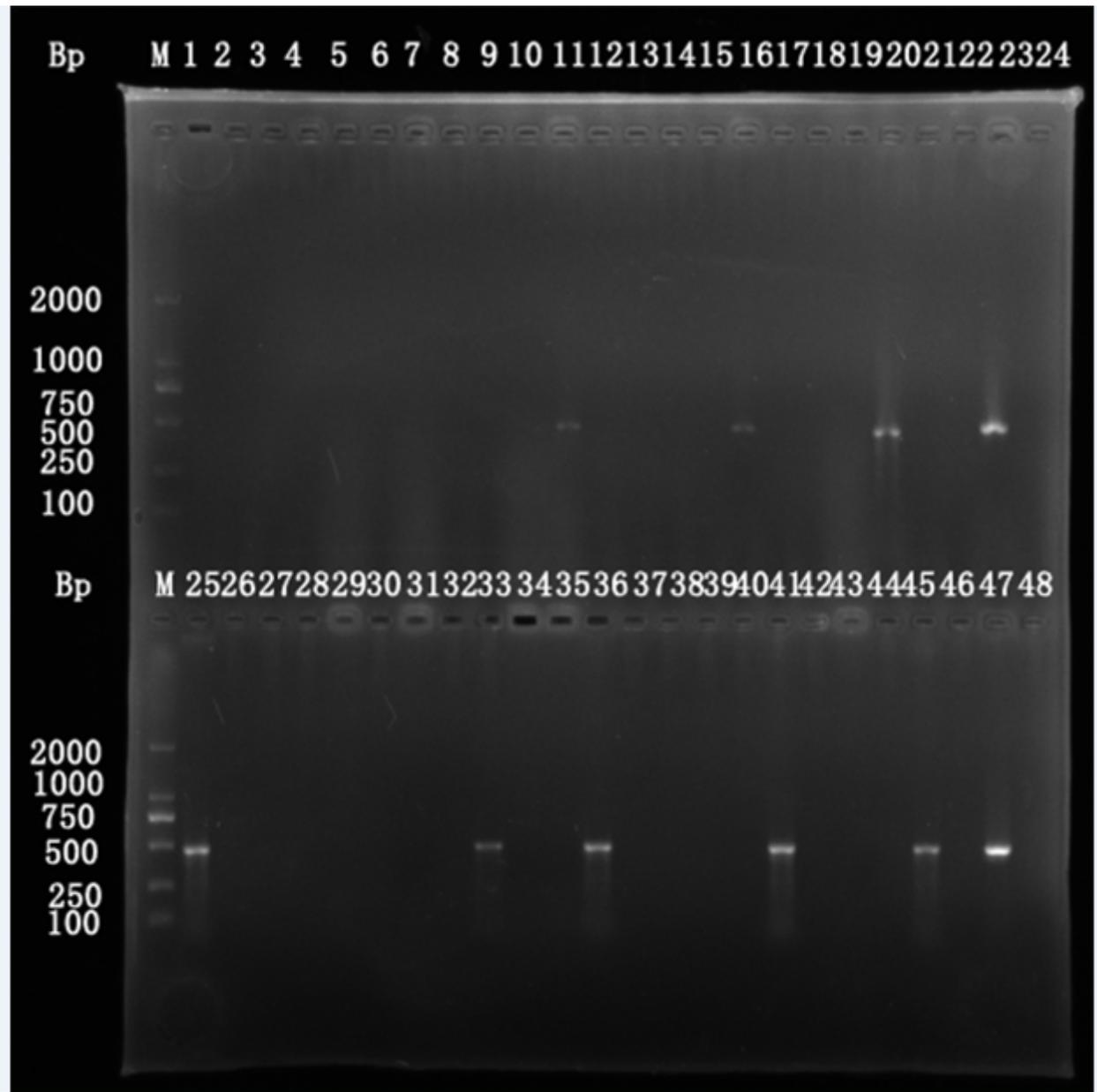


Figure 2

Results of PCR detection of the respondents

Supplementary Files

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- [TableS1Questionnaire.docx](#)
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