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Evaluation of an educational intervention on villagers' knowledge, attitude and behaviour regarding transmission of *Schistosoma japonicum* in Sichuan province, China

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Abstract

Health education is an important component of efforts to control schistosomiasis. In China, while education programmes have been implemented intensively, few articles in recent years in either the Chinese or English literature report randomised, controlled interventions of the impacts on knowledge, attitudes and behaviours .Thus, we designed and carried out a cluster-randomised controlled education intervention trial that targeted 706 adults from rural areas in 28 villages in Sichuan, China. We evaluated the effects of the intervention on five endpoints: (1) schistosomiasis knowledge, (2) attitudes towards infection testing and treatment, (3) use of personal protective equipment (PPE), (4) reducing defecation in the field, and (5) reducing dermal contact with potentially contaminated water sources. The results indicated that people in both the intervention and control groups showed improvement in knowledge, attitudes and reduction in field-defecation in the follow-up surveys. However, there was little evidence that suggested statistically significant differences between the two groups regarding any endpoint. Participation in intervention classes was associated with age, gender, occupation and education level. Our study suggests short-term health education interventions may not be effective in improving schistosomiasis knowledge or in the adoption of health-protective behaviours. This might be partially due to the spontaneous learning process of people subject to repeated surveys and other disease control activities. Considering the difficulties of occupationassociated behaviour change and knowledge reinforcement in general, longer-term education programmes should be considered in the future.

Keywords

Schistosomiasis; health educational intervention; randomised controlled trial; GEE regression; China

1. Introduction

Health education has been an important means of suppressing transmission of many infectious diseases (Ghosh et al., 2006; Aiello et al., 2008; Manabe et al., 2011; Amoran et al., 2012; Bieri et al., 2012; Gao et al., 2012). Despite the various mechanisms of disease transmission, the common goal is to enhance people's awareness of the infection risks, emphasise the significance and methods of disease prevention, increase their adoption of self-protective behaviours, and improve compliance with infection testing and treatment. For schistosomiasis, one of the most prevalent parasitic diseases with an estimate of more than 779 million people at risk worldwide (Steinmann et al., 2006), massive education programmes have been carried out in endemic areas (Kloos, 1995; Lansdown et al., 2002; Asaolu and Ofoezie, 2003). Not only have these programmes improved people's knowledge about the disease, they have also potentially reduced infection risks and enhanced the effectiveness of other control methods, including chemotherapy and environmental modification (Rollinson et al., 2012).

In China, health education has been a core element of schistosomiasis control programmes for several decades (Mao and Shao, 1982; Sleigh et al., 1998; Wang et al., 2009; Hong et al., 2011), although its effects were seldom evaluated through epidemiological studies until more recently. Most papers in the Chinese literature suggest that participants' knowledge of schistosomiasis and attitudes towards disease control were significantly improved as measured by survey results before and after the educational intervention (Chen et al., 2009; Yin et al., 2009; Zhou et al., 2012a). However, most studies failed to adopt randomised controlled trials to account for effects that may not have been due to the intervention, and detailed information on participant selection and enrolment, intervention protocols, and survey designs are rarely reported. Also, few studies considered potential confounders or conducted statistical analyses beyond pre-post mean comparisons. English articles on China's schistosomiasis educational interventions have also been scarce, and, to our knowledge, no original research papers specifically focused on this topic have been published in English journals since 2005. Moreover, most previous studies were conducted in the marshland environment along the lower Yangtze River (Hu et al., 2000; Yuan et al., 2000; Hu et al., 2005; Yuan et al., 2005), which is quite different from our primary focus in the irrigated agricultural environment of the hilly and mountainous regions. These differences include the landscape, economy, population demographics, and occupational and recreational activities that bring people in contact with potentially contaminated water sources (Spear et al., 2004; Liang et al., 2007; Zhou et al., 2007).

Here we report the results of a cluster-randomised controlled educational intervention trial targeting adults living in rural areas of two counties in Sichuan province. Over a 6-month period we conducted surveys on multiple endpoints that allowed for comprehensive analyses regarding the effects of the intervention on health-related knowledge, attitudes and behaviours. Accordingly, the hypotheses proposed for testing in this study were that: community-based health interventions improve people's knowledge of schistosomiasis, improve positive attitudes towards infection testing and treatment, reduce transmission-facilitating behaviours including defecating in the field and water exposure, and motivate self-protective behaviours including wearing personal protective equipment (PPE) for reducing dermal contact with potentially contaminated water sources.

2. Methods

2.1 Study population

Our intervention study is part of ongoing efforts to characterise determinants of schistosomiasis re-emergence in Sichuan (Carlton et al., 2011; Spear et al., 2011). Our initial cohort included residents in 53 villages in three counties where schistosomiasis re-emerged after human infection prevalence had previously been reduced to below 1% and transmission control was declared (Liang et al., 2006). We define a village as the smallest organizational unit in a region, which is also referred to as a production group or natural village. As described in detail elsewhere (Carlton et al., 2011), in 2007 we invited all residents of the 53 study villages, aged 6 years and older, to be tested for *Schistosoma japonicum* infection (Table 1). Due to the severe damage caused by the May 12th, 2008 Sichuan earthquake, we were unable to follow 17 villages from one county. This resulted in limiting eligible villages to the 28 villages in the two remaining counties where one or more human *S. japonicum* infections were detected 2007. Due to the sensitive nature of conducting infection surveys in regions where schistosomiasis transmission control criteria have officially been met, and to promote candid reporting, the names and exact locations of the counties and study villages have been withheld.

This study was conducted in conjunction with a case-control study whose objective was to identify the impact of individual behaviour on infection risk. In each study village, we invited all individuals to participate who were infected with *S. japonicum* in 2007 and, for each infected individual, four individuals randomly selected from those who tested negative for *S. japonicum* infection in 2007 (or, if more than one in four individuals were infected in a village, all uninfected individuals). As health education programmes focused on schistosomiasis are commonly implemented at schools in areas where the disease is endemic, we excluded people less than 18 years old. Thus, 706 people in 28 villages were eligible for participation in the intervention study.

The 28 selected villages were stratified by county and randomised by administrative village. An administrative village typically contains several natural villages that are geographically adjacent to each other, so residents of the same administrative village are much more socially connected than with outside residents. Thus, randomisation was applied on the administrative village level to reduce contamination bias. Using a random number generator, half of the administrative villages in each county (five in county 1 and three in county 2) were selected as intervention groups (13 total villages and 358 total eligible individuals). Correspondingly, the control group included the same numbers of administrative villages in each county as the intervention group, with a total of 348 eligible individuals in 15 villages.

2.2 Educational intervention

The educational intervention consisted of two sessions which were administered to the intervention group in April and late June of 2009. All interventions were class-based and led by trained staff from Sichuan Center for Disease Control and Prevention (Sichuan CDC). While eligible participants in the study were notified specifically by village leaders beforehand, all of the residents in the "intervention villages" were welcomed to participate shortly before the class began. The protocols of both intervention sessions were similar. Posters and display boards designed by the Chinese Ministry of Health and Sichuan CDC were put up 15 minutes before the class, and informal tutoring was made available to interested participants. The formal tutoring began with a brief outline of the format and contents of the class, followed by a verbal presentation that elaborated on the transmission, prevention, protection and treatment of schistosomiasis. To improve the effectiveness and attract more attention and participation, an educational video produced by China CDC was played in the first class, and prize-winning quizzes regarding some of the key points were conducted in the second class (Figure 1). In addition, a set of educational materials, including pamphlets, towels, schoolbags and other small items that had schistosomiasis-relevant knowledge printed thereon, were given to each household that had members eligible for the intervention study regardless of their participation (Figure 2). Each intervention class lasted for 1 to 1.5 hours based on the number of participants. The control group received the same intervention at the end of the evaluation in 2010.

2.3 Assessment of knowledge, attitudes and behaviours

We used two series of surveys for data collection. The first survey contained sections regarding people's knowledge, attitudes, use of personal protective equipment (PPE) and defecation behaviour, which was termed the KAE survey. KAE surveys were conducted three times: once before the intervention in 2008 (further referred to as "baseline"), the first follow-up in early June 2009 (after the first intervention but before the second intervention), and the second follow-up in October, 2009. Survey questions were selected from the "Question Base of Knowledge and Behaviour of Schistosomiasis" published by China CDC in 2007 [for the full survey, see appendix] (Chen et al., 2008). The knowledge questions tested participants' familiarity with the cause, symptoms, prevention and treatment of the disease. The attitude section inquired about the individual's willingness to be tested for *S. japonicum* and to take the anti-schistosomal drug, praziquantel, with the options ranging from "seeking the service actively" to "refusing the service" and ordered by ascending degree of compliance and initiative. The PPE section asked how frequently in the past 2 weeks the individuals used PPE (i.e. rubber boots or gloves) when contacting surface water during agricultural work. If responders reported no use of any equipment, participants were asked why, and responders claiming that they "did not farm at all" were not included in the analyses of this section. We scored each section using grading criteria described in detail in Appendix I-III. It should be noted that, although these scores were all formalised to the percentage scale, the significance of "one point" varied across the three sections. Due to the different number of questions and types of answers (ordinal in the attitude and behaviour sections, binary in the knowledge section), the scores of different sections should not be compared with one another. Finally, participants were also asked whether they had defecated in the fields in the past two weeks. An index to be used for regressions was created such that "1" stands for "frequently or occasionally defecated" and "0" for "never defecated".

The second survey was designed to assess the water contact (WC) magnitude of individuals, which was therefore termed as the WC survey. In 2008, WC surveys were conducted monthly between June and October of 2008 (WC data of May was collected during the June survey as, due to earthquake relief efforts, no interviews were conducted in May). While the surveys were originally designed as a means of investigating the determinants of schistosomiasis re-emergence, a portion of the results reflected people's dermal exposure levels prior to the intervention and thus were used as the baseline data. For comparison, we collected information on WC behaviours in May, July, September and October of 2009. Unlike the KAE surveys which required all participants to respond in person, family members were allowed to report WC patterns of study participants that were absent at the time of the WC survey. A total of 10 categories of activities were used in the surveys: washing clothes, washing agricultural tools, washing hands or feet, playing and swimming, ditch cleaning or diverting, rice planting, rice harvest, fishing, washing vegetables, and drinking or cooking. For each activity, noted as A, participants were asked to report as many as three locations L where this activity occurred, as well as the frequency F and duration D, measured by minutes/event, at each location. Accordingly, the total amount of WC for the ith individual in each month m, measured by the total number of minutes, is estimated by:

$$WC_{i,m}=\sum_{A}\sum_{L}F \cdot D \qquad (1)$$

To compare reported WC before and after the intervention, we calculated the total WC reported in May, June, September and October each year. We classified individuals whose total WC declined from 2008 to 2009 or remained zero both years as improved. Individuals whose WC increased from 2008 to 2009 or remained constant and above zero were classified as unimproved.

2.4 Statistical analyses

The individuals included in subsequent analyses were defined based on their degree of participation in the various surveys (see timeline Table 1). For KAE surveys, we included only people who participated in all three surveys for analyses to yield more meaningful comparisons. On the other hand, we utilized WC survey results to compare each individual's WC magnitude between the years of 2008 and 2009, which thus required that the study population must also have provided complete WC profiles for all four peak months of the infection season (May, July, September and October) in both years.

We used an intention-to-treat approach to analysis, including all individuals in their assigned treatment group regardless of whether they attended the intervention sessions. Prior to analysis, we examined the distribution of all continuous outcomes to confirm that parametric analysis methods were appropriate.

Although the intervention group assignment was randomised and therefore theoretically independent of any variables that might impact knowledge, attitudes and behaviours, the study population included in the analyses was a subset of the eligible population due to incomplete participation. As age, gender, education, occupation and county were possibly associated with people's participation of the surveys, these variables were considered as potential confounders in the analyses.

We used linear regression to evaluate the impact of the intervention on knowledge scores, attitude scores and the use of PPE, comparing the intervention to control group at each follow-up period. Logistic regression was used to evaluate the impact of the intervention on defecation practices and WC. We used generalized estimating equations (GEE) to account for within-village correlation (Liang and Zeger, 1986). Regarding model options, robust regression was applied with individuals clustered by village and exchangeable correlation assumed. For each outcome, we calculated unadjusted and adjusted effect estimates.

Finally, as an educational intervention study, it is meaningful to identify the factors that were associated with participation in the intervention, i.e. which subset of people were most likely to attend. Using the records of the first intervention (June, 2009), associations between attendance and each demographic variable are listed separately below.

All survey data were input using EpiData© version 3.1 (The EpiData Association, Odense, Denmark) and analysed with STATA© version 12.1 (StataCorp LP., College Station, TX, USA).

2.5 Ethics

The protocols of this study, including all of its relevant sections, were reviewed and approved by the Sichuan Institutional Review Board and the University of California, Berkeley, Committee for the Protection of Human Subjects. All participants provided written informed consent before participating in this study. All of the surveys and interventions were conducted by provincial and/or county CDC staff using the local dialect. Each person who tested positive for *S. japonicum* was provided treatment with 40 mg per kg of praziquantel tablets by the county Anti-Schistosomiasis Control Station.

3. Results

3.1 Study population summarization

Table 2 describes the eligible population and the people who completed the KAE and WC surveys. Farmer was the primary occupation for the majority due to the agriculture-based economy in these rural areas. Nearly two-third of the eligible individuals in both groups were people aged 40 years and above. This rather disproportionate fraction was associated with the nationwide phenomenon in China that younger people from rural areas tend to work in cities and leave children and the elderly population home. Only 29.4% of the eligible individuals completed the KAE surveys; the intervention group had relatively better participation than the control group (37% vs. 22%).There was also a difference in participation by county: the proportion of people who completed the KAE surveys in county 1 was approximately one third of county 2 (16.8% vs. 58.4%). For the WC surveys, because family members were allowed to report WC patterns of study participants that were absent at the time of the survey, the proportion of people enrolled in the analyses was much greater (62.5%).

3.2 Baseline result summarization

Table 3 presents the results of the baseline KAE and WC surveys conducted in 2008. For the knowledge section, the percent of participants answering each question correctly was similar in intervention and control groups, but the responses reveal gaps in people's knowledge of schistosomiasis: 76% of the people could not name the anti-schistosomal drug, and 53% did not know any symptom of infection. Only half (51%) were aware of the possibility of re-infection after treatment, and the proportion that could list any self-protective method was 58%.

The results of the attitude section were relatively positive: 94% of the people would be willing to either "proactively seek infection testing and treatment" whenever they suspect being infected, or "comply actively when these services are available in the village"; only a few people in each groups would completely refuse the services.

In comparison, the compliance of PPE using was rather poor. More than 85% of all people did not use hand-protection equipment or protective ointments during agricultural work. Even the most-frequently used equipment (rubber shoes or boots), only 40% of people used them on a regular basis. Regarding other behaviours associated with disease transmission, 19% of people had defecated in the fields during the 2 weeks before the survey, and 87% of people reported some level of WC in 2008.

3.3 Knowledge

The unadjusted averaged scores from the knowledge section show that the intervention group outscored the control group by only a small margin at baseline but by greater margins in the two follow-ups. This trend was consistent with the regression results, which showed that the point estimates of within-group score difference in the follow-ups were all much higher than those of the baseline. However, none of the estimates of between-group differences were statistically significant, with the only exception being the adjusted result of the first follow-up [95% confidence internal (CI): 1.03, 13.12]. On the other hand, both groups had marked longitudinal improvements. Comparing the unadjusted results between the baseline and the second follow-up, the score increased by 13.3 points in the control group and 17.7 points in the intervention group.

3.4 Attitudes

For the attitude section, the averaged unadjusted scores of the two groups were very close in the baseline survey (Table 4) and statistically insignificant. Although the score difference by which the intervention group surpassed the control group increased slightly in the follow-up surveys, this pattern was not supported by the regression results where the minimum estimates of both unadjusted and adjusted models were found at the first follow-up. Further, all estimates of the between-group differences were relatively small and likely to be due to chance, so there was little evidence provided by intergroup comparisons that indicate effects of intervention on attitudes. However, similar to the knowledge section, both groups' scores improved from the baseline to a noticeable extent, and as expected, greater improvement was found in the intervention group.

3.5 PPE wearing behaviour

Little difference was found between the two groups in the baseline survey due to both the unadjusted score comparisons and model regressions. For the first follow-up, the between-group difference was even smaller. While the intervention group had 5.5 more averaged points, or 4.4 points after adjusted for confounders, than the control group in the second follow-up, this finding was again insignificant. Unlike the previous two endpoints, there was no sign that people from either group had any improvement in self-reported PPE wearing behaviour.

3.6 Defecation behaviour

In the first two surveys, the proportion of people who defecated in the fields was slightly smaller in the intervention group. While this finding was consistent with what were suggested by the odds ratios (ORs) from model regressions (OR>1), none of these estimates was statistically significant. In the last survey, the proportion in the intervention group was less than half of the control group, and much higher ORs were detected with lower p-values (OR=3.28 and p=0.185 for the adjusted estimate). Also, consistent "improvement" was found for this behaviour within groups as well, meaning that the proportions that defecated decreased with time in both groups. Compared to the control group that had a 63% drop from baseline to the final survey, this proportion was reduced by 81% in the intervention group.

3.7 WC behaviour

Table 5 shows the results of the logistic regressions regarding WC change from 2008 to 2009. Both ORs, with and without confounders adjusted, were marginally larger than unity, meaning that those in the intervention group were slightly more likely to reduce their level of WC compared to the control group. Again however, the p-values indicated that none of the findings were statistically significant. Thus, no evidence was found in our dataset which suggested an effect of education in reducing people's WC behaviour.

3.8 Longitudinal effects

As mentioned above, while little difference was detected between groups, some clear longitudinal effects were found in both groups in three endpoints: knowledge, attitudes and defecation behaviour. Regressions on the individual level confirmed these trends (Table 6). For the control group, statistically significant improvements were found on the knowledge endpoint in the first follow-up survey, and on all three endpoints in the second follow-up with greater margins. Longitudinal improvements in the intervention group were even more striking – stronger effects were found for all three endpoints in both follow-ups, and most results were highly unlikely to be due to chance.

3.9 Intervention participation

Table 7 shows the characteristics of the individuals who participated in the intervention in April 2009. As expected and noted earlier, participants were not evenly distributed by the various demographic variables. Specifically, elderly people, females, farmers, people without post-elementary education and people from county 2 were more likely to participate than their counterparts in other subgroups. However, the infection status of people in the previous two years (2007, 2008) was not related to participation. As all individuals diagnosed as infected were notified, knowledge of one's infection apparently did not prompt the individual to participate in the education classes.

4. Discussion

The results of our intervention trial showed no statistically significant differences between the intervention and control groups in four endpoints – attitude and three types of behaviour – defecation, PPE wearing and WC. Although, in the first follow-up survey, the intervention group had a significantly higher score in the knowledge section, this pattern was not sustained in the second follow-up. In sum, no clear evidence was found suggesting any effect of the intervention through intergroup comparisons.

On the other hand, both groups showed quite significant longitudinal improvement in knowledge, attitude and defecation behaviour, although somewhat greater improvements were seen in the intervention group as might be expected. First, it is possible that some people in the control group may have become more familiar with the subjects covered in the questionnaire by participating in repeated surveys. However, we speculate that this result is a more general example of the theory of diffusion of innovations (DOI), first introduced by Rodgers over 40 years ago (Rogers, 2003). DOI theory concerns the spread of ideas through social networks. In addition to introducing new ideas into the social network through the intervention itself, many other activities, such as snail surveys, molluscicide treatment and the development of rural infrastructure were carried out during the same period, and in the same general region, as part of disease control programmes. While contamination bias was specifically considered during group formation, there were no restrictions preventing people in different groups from communicating or discussing the contents of the educational intervention during or subsequent to any element of the trial. Hence, there was opportunity for the diffusion of the information among farmers and other village residents in the region.

While the defecation behaviour appears to have been affected, WC and PPE wearing behaviours were not, perhaps because they are difficult to alter in any sustainable way in this environment. In the hilly and mountainous rural areas of Sichuan, agricultural machinery is less available and useful, and farming is mostly accomplished by humans and bovines. As we focused on adults only and, as earlier stated, >80% of the study population were farmers, their work-associated WC is very difficult to avoid. In this context, self-protection during agricultural work plays an important role of reducing the risk of infection, at least in principal. However, PPE wearing behaviours were not improved by the intervention, and both groups had similarly low scores across all three surveys. The lowest scores were found in the first follow-up (June 2009), suggesting that the least protection was used during the spring planting season when most WC occurred. When asked about the reason for not using any protection, most people responded that "however useful in interrupting transmission, it was uncomfortable and inconvenient to wear rubber gloves or boots while working in the fields". While this illustrates the difference between understanding the benefit and modifying behaviour, as suggested in other studies of occupationally-related behaviour change (Hu et al., 2005), it also raises the issue of the practicalities of sustained personal protection in an inherently risky environment. As we have argued elsewhere, a focus on environmental improvements and monitoring systems to signal early risks of infection are better long-term solutions than personal protection in rural China as they are in occupational settings worldwide (Spear et al., 2011).

An important objective of this study is to facilitate improved design of education and control programmes. For instance, it was shown in all three KAE surveys that a large proportion of people were not aware of the re-infection possibility or familiar with disease symptoms, both of which may lower their chance of receiving timely diagnostic testing and treatment. These are examples of the points that should be emphasised in future educational programmes. Also, the analysis suggested there to be "vulnerable" members of the community that should be specifically targeted in the future. For example, it was found that the elderly people and women appeared to be less knowledgeable about schistosomiasis compared to those in other subgroups both before and after the intervention. However, these same groups were well-represented in the intervention trial suggesting the need for alternative educational strategies.

The advantages of our study over earlier work included a combination of various educational formats and multiple media to engage participants' attention. Second, we carried out longitudinal surveys on multiple endpoints that could all be impacted by the intervention. Third, the finding that improvements over time were also observed in the control group clearly demonstrated the value of a randomised controlled trial in understanding the effects of intervention.

There are some limitations of our study. First, participation in the surveys and interventions was markedly poorer in county 1 than in county 2.This might be due to the fact that a greater fraction of the study population from county 1 worked in urban areas and because these emigrant workers come back only occasionally, their participation was inherently more difficult. Second, as mentioned above, contamination bias was not completely preventable, as social connections were fairly common and frequent in the rural areas. Finally, considering the inherent challenges of knowledge assimilation and behaviour change, it is possible that a longer study period would have been more effective.

After decades of continuous effort, China is aiming to lower the prevalence of schistosomiasis to less than 1% by the year of 2020 as the next step in moving towards interruption of transmission (Zhou et al., 2012b). To achieve this aim, one of the biggest challenges is to further reduce the infection level to below the current low-transmission setting as shown by re-emergence of the disease in some regions that had once reached the interruption criteria (Utzinger et al., 2005; Zhou et al., 2005; Liang et al., 2006). Although comprehensive control strategies tailored to local conditions remain under study, health education is still widely considered as a cost-effective method of lowering the individual risk of infection (Liu et al., 2012; Rollinson et al., 2012). However, unlike what is suggested in many other studies that also enrolled a control group (Zhou et al., 2012a), the effects of our education intervention, evaluated through knowledge, attitudes and behaviours, were not strong enough to yield statistically significant differences between the intervention and control groups. Also, occupation-related behaviour change was shown to be extremely difficult. These findings, while not denying the potentially important role of health education in future schistosomiasis control, does suggest the necessity of exploring new ways of conducting education programmes that work more effectively in the current low transmission environments.

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Appendix: I. Grading criteria for the knowledge section

There are three types of questions in the knowledge section. For the multiple choice and true/false questions shown in Table A-1, only one answer is correct for each question, full grade is given only when the right option is selected.

Table A-1

Multiple-choice and true/false questions in the knowledge section

Multiple-choice questions (options omitted)	*What is the cause of schistosomiasis?*
	Untreated schistosomiasis will cause what type of body change?
	What is the shape of the intermediate snail (Oncomelania hupensis)?
	Most of the transmission occurs in which months during a year?
	What is the drug for schistosomiasis treatment used in the local areas?
True/False questions	*Will the faeces of infected animals be able to transmit the disease?*
	After treatment, will people be infected again if they contact contaminated water?

Further, responders are required to list the symptoms and protective methods of schistosomiasis. The preset options, shown in Table A-2, will be checked if the corresponding symptoms are mentioned by the responder. Extra grades will be assigned if the responder mentions other symptoms that are correct but not listed in the options.

Table A-2

Self-report questions in the knowledge section

Self-report questions	**Pre-set options to be checked if mentioned**
What types of symptoms might be associated with schistosomiasis infection?	Fever
	Diarrhoea
	Bloody faeces
	Fatigue
	Cough
Do you know any methods that are preventive of getting infected while working in the fields?	Wear boots or rubber shoes
	Wear rubber gloves or tools with handles
	Use protective ointment

All questions in the knowledge section are weighted equally with a total of 100 points. Since there are 15 questions/options in total, each question is worth 6.6 points.

Appendix: II. Questions and grading criteria of the attitude section

There are two questions for grading and two follow-up questions in the attitude section. The questions as well as the grading criteria are shown in Table A-3:

Table A-3

Questions and grading criteria of the attitude section

Question for grading	Grading criteria	Follow-up question (not for grading)
1. Regarding infection tests in the future, you will: 1) Take the test proactively whenever suspecting being infected 2) Comply actively whenever the test is conducted in the village by schistosomiasis control organizations 3) Take the test only when being asked to 4) Refuse to take the test	1) => 5 points 2) => 4 points 3) => 2 points 4) => 0 point	*If (4), then ask:* Why will you refuse to take the test? (1) The blood test hurts (2) It is troublesome to collect the stools (3) It is unnecessary as I don't feel uncomfortable (4) It is unnecessary as I must be infected (5) Others, please specify_________
2. Regarding treatment in the future, you will: 1) Take the treatment proactively if infected 2) Comply actively when treatment or mass chemotherapy is provided in the village by schistosomiasis control organizations 3) Take the treatment or mass chemotherapy only when being asked to 4) Not take the treatment due to other diseases 5) Refuse to take the treatment	1) => 5 points 2) => 4 points 3) => 2 points 4) => "N/A" 5) => 0 point	*If (5), then ask:* Why will you refuse to take the test? (1) The side effects are uncomfortable (2) Unwilling to comply with mass chemotherapy if found uninfected (3) Unwilling to take the drugs until feeling sick (4) Others, please specify_________

Not applicable is assigned to option (4) of the second question because the special situation that it indicates does not represent the responder's attitude towards treatment. However, this option was not selected in any of the three surveys.

Appendix: III. Questions and grading criteria of the personal protective equipment (PPE) wearing section

The five questions and grading criteria of the behaviour section are shown in Table A-4.

Table A-4

Questions and grading criteria of the PPE wearing behaviour section

Question for grading			Grading criteria	Follow-up question (not for grading)
In the past month, when working in the snail-residing water environments, did you…	(1) wear rubber shoes?	1) Frequently 2) Occasionally 3) Never	1) => 5 points 2) => 3 points 3) => 0 point	*If answering "never" to all questions, then ask:* Why do you refuse to use protection? (1) Don't think these methods are effective (2) However useful, these methods are inconvenient for working in the fields (3) Wearing boots and rubber shoes cannot protect hands so I will get infected anyway (4) Others, please specify_________
	(2) wear long rain boots?			
	(3) wear rubber gloves?			
	(4) use protective ointment?			

As methods (1) and (2) can practically be substitutes with one another, we take only the higher point from these two questions when calculating the total score.

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Highlights

- Conducted a randomised controlled trial of an education intervention among 706 people in China
- Evaluated the effects regarding 5 endpoints on knowledge, attitudes and behaviours
- Detected a diffusion of knowledge effect by comparing longitudinal results in each group
- Intergroup differences were mostly statistically insignificant in follow-up surveys
- Showed problems of short-term interventions and suggested a need for new education designs

Figure 1.
Educators from Sichuan CDC conducting the second intervention class in uses of educational posters (on the back) and in-class quizzes (prizes on the table) in two villages

Figure 2.
Educational materials distributed to families with members eligible for the educational intervention

Table 1

Timeline of the health education intervention and evaluation surveys.

	2007		2008					2009				
	Jun	**Nov - Dec**	**Jun**	**Jul**	**Sep**	**Oct**	**Nov**	**Apr**	**Jun**	**Jul**	**Sep**	**Oct**
Demographic survey *	X											
Infection survey †		X					X					
Education intervention Ŧ								X	X			
KAE survey ‡							X		X			X
Water contact survey **			X	X	X	X			X	X	X	X

*Collected demographic information including age, sex, occupation, education, and village of residency

†Tested for *S. japonicum* infection status; see detailed methods of infection testing in (Carlton et al., 2011)

ŦThe intervention survey consisted of class-based education interventions to the intervention group

‡Included three sections: knowledge of schistosomiasis, attitude towards infection testing and treatment, defecation practices and self-protective behaviours of wearing personal protective equipment

**Asked about WC behaviours in the past 2 weeks. The June, 2008 survey asked about WC behaviours in both May and June; the October, 2009 survey asked about WC behaviours in both September and October.

Table 2

Characteristics of the eligible population and study participants in an evaluation of a health education intervention in Sichuan, China.

	Eligible population		Complete participation in the KAE surveys *		Complete participation in the WC surveys **	
	Control	Intervention	Control†	Intervention†	Control†	Intervention†
	No.	No.	%	%	%	%
Total	348	358	22	37	61	64
Age (years)						
18-29	23	25	0	8	43	52
30-39	75	61	15	23	57	44
40-49	100	83	22	34	63	69
≥50	150	189	29	46	65	70
Sex						
Female	177	187	28	45	60	64
Male	171	171	16	28	63	64
Education						
Elementary school or no schooling	211	230	23	41	63	73
At least some middle school or higher	111	89	18	26	73	66
Occupation						
Not Farmer	44	65	5	20	61	65
Farmer	274	253	24	42	67	74
County						
1	284	203	13	22	59	66
2	64	155	64	56	73	62

*Included three sections: knowledge of schistosomiasis, attitude towards infection testing and treatment, and self-protective behaviours of wearing personal protective equipment

†Percentages are calculated by dividing the number of enrolled people in each cell by the number of eligible population in the corresponding cell.

**Asked about WC behaviours in the past 2 month, including the location, frequency and duration associated with each of the 10 WC categories

Table 3

Schistosomiasis knowledge, attitudes towards testing and treatment and behaviours reported at baseline.

		Control group (N = 77)	Intervention group (N = 131)
		%	%
Knowledge			
Know that the cause of infection is contacting contaminated water		68.8	67.2
Know that schistosomiasis will lead to enlarged abdomen		67.5	67.9
Know the shape of the intermediate snail		79.2	77.1
Know the months during which most of the transmission occurs		64.9	77.9
Know the drug for schistosomiasis treatment		23.4	23.7
Know that the faeces of infected animals can transmit the disease		70.1	60.3
Know that people can be re-infected after treated		55.8	48.9
Know how many symptoms of schistosomiasis infection	0	61.0	48.1
	1	20.8	37.4
	2	15.6	8.4
	≥3	2.6	6.1
Know how many self-protective methods	0	42.9	41.9
	1	45.5	52.7
	≥2	11.7	5.4
Attitudes			
Infection testing			
I will take the test proactively whenever I suspect that I am infected		19.5	14.5
I will comply actively when infection testing is provided in the village		71.4	82.5
I will take the test only when I am asked to		3.9	1.5
I refuse to take the test		5.2	1.5
Infection treatment			
I will take the treatment proactively if I am infected		22.1	13.7
I will comply actively when treatment is provided in the village		70.1	85.5
I will take the treatment only when I am asked to		5.2	0
I refuse to take the treatment		2.6	0.8
Behaviours			
Personal protective equipment (PPE) used while working in the fields			
Wear rubber shoes or boots	Frequently	39.0	42.8
	Sometimes	54.5	45.0
	Never	6.5	12.2
Wear rubber gloves or use handled tools	Frequently	2.6	0.7
	Sometimes	9.1	15.3
	Never	88.3	84.0
Use protective ointment	Frequently	0	0

		Control group (N = 77)	Intervention group (N = 131)
		%	%
	Sometimes	7.8	13.0
	Never	92.2	87.0
Defecated in the fields in the past 2 weeks		20.8	18.3
Water contact (WC) *			
Reporting any WC (sum of June, July, September and October of 2008)		85.5	88.6

*214 individuals in the control group and 229 individuals in the intervention group

Table 4

Comparisons of schistosomiasis knowledge, attitudes towards treatment, PPE wearing and defecation practices in the intervention and control groups.

	Averaged unadjusted results*		Unadjusted group difference (95% CI)†	Adjusted group difference (95% CI)†‡
	Control (N = 77)	Intervention (N =131)		
Knowledge score (out of 100)				
Baseline	37.3	37.5	1.91 (−6.64, 10.46)	2.31 (−5.17, 9.79)
First follow-up (06/2009)	42.1	46.8	6.09 (−1.11, 12.55)	7.07 (1.03, 13.12)
Second follow-up (12/2009)	50.6	55.2	5.23 (−2.60, 13.06)	4.91 (−4.06, 13.87)
Attitude score (out of 100)				
Baseline	81.2	82.6	3.21 (−1.53, 9.74)	2.26 (−2.68, 7.19)
First follow-up (06/2009)	82.5	84.5	1.87 (−3.32, 7.06)	1.55 (−4.20, 7.29)
Second follow-up (12/2009)	87.3	91.0	2.56 (−2.28, 7.40)	3.65 (−1.75, 9.05)
PPE wearing behaviour score (out of 100)				
Baseline	28.8	30.2	2.20 (−6.12, 10.53)	1.74 (−6.12, 9.60)
First follow-up (06/2009)	14.1	14.1	1.62 (−4.24, 7.48)	1.78 (−4.18, 7.74)
Second follow-up (12/2009)	24.9	30.4	5.05 (−2.26, 12.38)	4.42 (−3.38, 12.22)
Defecation behaviour (binary)				
Baseline	18.7	17.0	1.09 (0.27, 4.43)	1.54 (0.45, 5.24)
First follow-up (06/2009)	10.3	8.1	1.19 (0.27, 5.21)	1.21 (0.32, 4.53)
Second follow-up (12/2009)	7.0	2.4	2.53 (0.44, 14.39)	3.28 (0.57, 18.98)

*For the knowledge, attitude and PPE wearing sections, cells represent the averaged unadjusted scores; for the "defecation" question, cells represent the proportions of people who **DID** defecate in the fields.

†For the knowledge, attitude and PPE wearing sections, cells represent score differences based on regression results; positive numbers correspond to higher scores in the intervention group. For the "defecation" question, cells represent the odds ratios (intervention group/control group) of **NOT** defecating in the fields.

‡Adjusted for age, gender, education, occupation and county.

Table 5

Unadjusted and adjusted odds ratios between the intervention and control groups regarding WC change from 2008 to 2009.

Outcome variable	Unadjusted odds ratio* (95% CI)	Adjusted odds ratio (95% CI) *†
WCC_i	1.29 (0.59, 2.83)	1.15 (0.55, 2.43)

*The odds ratio describing the odds of an improvement in WC in the intervention group vs. the control group. Individuals whose total WC (the sum of May, June, September and October) declined from 2008 to 2009 or remained zero both years were classified as improved. Individuals whose WC increased from 2008 to 2009 or remained constant and above zero were classified as unimproved.

†Adjusted for age, gender, education, occupation and county.

Table 6

Longitudinal changes on knowledge and attitudes scores and the defecation behaviour in each study group.

	Control group (95% CI)		Intervention group (95% CI)	
	First follow-up (06/2009)	**Second follow-up (12/2009)**	**First follow-up (06/2009)**	**Second follow-up (12/2009)**
Knowledge *	4.76 (0.19, 9.33)	13.25 (8.15, 18.34)	9.36 (5.47, 13.25)	17.71 (13.99, 21.43)
Attitudes *	1.24 (−3.04, 5.51)	6.09 (2.12, 10.05)	1.95 (−0.10, 3.99)	8.45 (6.09, 10.81)
Defecation Behaviour †	2.00 (0.75, 5.31)	3.02 (1.04, 8.77)	2.33 (1.13, 4.79)	8.38 (2.47, 28.45)

GEE models with robust estimations were applied. Options were made to cluster individuals and assume exchangeable correlations. All cells are relative to the baseline KAE survey (2008).

*Cells represent score differences

‡Cells represent odds ratios

Table 7

Associations between demographic characteristics and participation of the first intervention.

	Eligible (No.)	Participated (No.)	Participation (%)	p-value
Total	**407**	**276**	**(68)**	
Age (years)				
<18	50	28	(58)	0.001 *
18-29	24	11	(42)	
30-39	61	35	(57)	
40-49	83	57	(69)	
≥50	189	145	(77)	
Sex				
Female	212	155	(73)	0.017
Male	195	121	(62)	
Education				
Elementary school or no schooling	257	183	(71)	0.019
At least some middle school or higher	98	57	(58)	
Occupation				
Not Farmer	73	38	(52)	<0.001
Farmer	254	189	(74)	
County				
County 1	220	118	(54)	<0.001
County 2	187	158	(84)	
Previous infection †				
Yes	240	170	(71)	0.809
No	104	75	(72)	

*Test for trend; age categories are treated as ordinal

†Based on the results of the 2007 and 2008 infection tests; "Yes" means infection in either test