Protection Motivation Theory in Predicting Intention to Engage in Protective Behaviors against *Schistosomiasis* among Middle School Students in Rural China

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**Abstract**

**Background:** Among millions of people who suffer from *schistosomiasis* in China, adolescents are at increased risk to be infected. However, there is a lack of theory-guided behavioral prevention intervention programs to protect these adolescents. This study attempted to apply the Protection Motivation Theory (PMT) in predicting intentions to engage in protective behaviors against *schistosomiasis* infection.

**Methods:** The participants were selected using the stratified cluster sampling method. Survey data were collected using anonymous self-reported questionnaire. The advanced structural equation modeling (SEM) method was utilized to assess the complex relationship among *schistosomiasis* knowledge, previous risk exposure and protective measures in predicting intentions to engage in protective behavior through the PMT constructs.

**Principal Findings:** Approximately 70% of participants reported they were always aware of *schistosomiasis* before exposure to water with endemic *schistosomiasis*, 6% of the participants reported frequency of weekly or monthly prior exposure to snail-conditioned water, 74% of participants reported having always engaged in protective behaviors in the past three months. Approximately 7% were unlikely or very unlikely to avoid contact with snail-conditioned water, and to use protective behaviors before exposure. Results from SEM analysis indicated that both *schistosomiasis* knowledge and prior exposure to *schistosomiasis* were indirectly related to behavior intentions through intrinsic rewards and self-efficacy; prior protective behaviors were indirectly related to behavior intentions through severity, intrinsic rewards and self-efficacy, while awareness had an indirect relationship with behavior intentions through self-efficacy. Among the seven PMT constructs, severity, intrinsic rewards and self-efficacy were significantly associated with behavior intentions.

**Conclusions:** The PMT can be used to predict the intention to engage in protective behaviors against *schistosomiasis*. *Schistosomiasis* intervention programs should focus on the severity, intrinsic rewards and self-efficacy of protection motivation, and also increase the awareness of infection, and enrich the contents of *schistosomiasis* education.

**Citation:** Xiao H, Li S, Chen X, Yu B, Gao M, et al. (2014) Protection Motivation Theory in Predicting Intention to Engage in Protective Behaviors against *Schistosomiasis* among Middle School Students in Rural China. PLoS Negl Trop Dis 8(10): e3246. doi:10.1371/journal.pntd.0003246

**Editor:** Peter J. Hotez, Texas Children’s Hospital, National School of Tropical Medicine, United States of America

**Received** May 14, 2014; **Accepted** September 5, 2014; **Published** October 16, 2014

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**Data Availability:** The authors confirm that all data underlying the findings are fully available without restriction. All relevant data are within the paper and its Supporting Information files.

**Funding:** The authors received no specific funding for this work.

**Competing Interests:** The authors have declared that no competing interests exist.

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**Introduction**

Prevention of *schistosomiasis* has been a significant public health challenge in tropical and subtropical regions of the world. *Schistosomiasis* epidemic has been recorded in 80 countries, and more than 240 million people are infected and 700 million are susceptible [1,2]. The global disability-adjusted life years (DALY) attributed to *schistosomiasis* exceeded 70 million in 2008 [3]. Data collected in China in 2011 reported that 286,836 people were infected with *schistosomiasis*, and 30,028 patients were diagnosed with advanced *schistosomiasis*. A recent report estimated that about 372,644.10 hectares of areas in China was infested with *Oncomelania* snail, a species of snail known to be the primary vector for *schistosomiasis* [4].

Because of the lack of the acquired immunity, adolescents tend to have higher infection rates than adults [5,6]. One study in Uganda found that the prevalence rate and the severity of *schistosomiasis* infection often peaked between 10 and 14 years of age and then declines with increasing age [7]. This results are consistent with reports from South Sudan where children aged 10–14 years have the highest infection rate, in addition, school-aged children (6–15 years) were being more likely to be infected than...
Author Summary

In China, millions of population suffer from schistosomiasis infection and adolescents tend to have higher infection rates than adults. The Knowledge-Attitude-Practice (KAP) Theory has traditionally been used as guidance to schistosomiasis prevention in China. However, despite increases in knowledge among residents in the epidemic areas due to KAP theory-based schistosomiasis health education, no significant reduction in water-contact behavior was evident. Therefore, it is of crucial importance to seek alternative health behavior change theories/models that are more effective than the KAP theory to promote purposeful behavioral change. The Protection Motivation Theory (PMT) as a social cognitive model may be an alternative to the KAP theory. In this study, we found that the PMT can be used to predict intention to engage in protective behaviors against schistosomiasis infection among middle school students in rural China. Based on the PMT, in addition to enhancing awareness of schistosomiasis infection, intervention programs should focus on the severity, intrinsic rewards and self-efficacy of protection motivation.

The Knowledge-Attitude-Practice (KAP) Theory has traditionally been used as guidance to schistosomiasis prevention in China. This approach emphasizes the knowledge of, correct attitudes towards schistosomiasis and practical skills to reduce the likelihood of making contact with snail-conditioned water [22–26]. One experimental study indicated that receiving a health education program reduced contact with snail-conditioned water from 14.5% at the baseline to 1.8% at one-year follow-up, and the corresponding infection rate from 13.9% to 2.2% among students in a heavy epidemic rural area around the Poyang Lake [22]. However, findings in this study have never been repeated. On the contrary, reported studies frequently show that numerous people who have adequate knowledge of and correct attitudes toward schistosomiasis do not engage in any protective behavior [23–29]. Furthermore, study findings also reveal that despite increases in knowledge among residents in the epidemic areas due to KAP theory-based schistosomiasis health education, no significant reduction in water-contact behavior and schistosomiasis infection have been evident [28,29].

The phenomenon of “knowledge-practice” separation [30,31] described above encouraged many researchers to seek for alternative theories/models that are more effective than the KAP theory to promote purposeful behavioral change. Some researchers suggest that there is an imbalance between knowledge accumulation and behavioral change; therefore increases in knowledge alone may not be adequate to change a person’s attitude and behaviors [32]. In addition, cognitive process may play a key role in the process of decision-making, leading to behavioral change [31].

A review of intervention research literature indicated that the Protection Motivation Theory (PMT) [33–35] has been frequently used in HIV prevention research [36–38]. The PMT was first introduced by Rogers [33] to understand mechanisms by which people adopt protective behaviors to reduce perceived threat. This model has been revised several times with improved capacity in predicting health-related behaviors [39–43]. As a social cognitive model, PMT consists of seven constructs organized as two pathways linking perceptions to behavior (Figure 1). (1) The threat appraisal pathway - an evaluation of a person’s perception of the threat of certain behaviors or diseases; and (2) The coping appraisal pathway - an evaluation of a person’s ability to copy with the threat. The threat appraisal pathway consists of four constructs in two groups, with one group assessing perceived threat using two subconstructs (severity, and vulnerability) and another group assessing the perceived rewards also using two subconstructs (i.e. intrinsic rewards and extrinsic rewards). Coping appraisal pathway consists of three subconstructs in two groups, with one group assessing perceived efficacy with two subconstructs (i.e. response efficacy and self-efficacy) and another assessing perceived costs (i.e. response costs).

The PMT may be an alternative to the KAP, because it integrates cognitive process with information, knowledge, attitudes to behavior intentions and further to behaviors [39]. The objective of this study was to investigate the applicability of the PMT in understanding the schistosomiasis-related knowledge, experiences, attitudes and behavior among young students in China. We hypothesize that schistosomiasis knowledge and awareness of schistosomiasis, prior exposure to snail-conditioned water, and engagement in protective behaviors will be associated with the PMT constructs, while PMT constructs will predict intentions to engage in protective behaviors. Our purpose is to provide new data supporting theory-based and more effective behavioral interventions for primary prevention of the schistosomiasis epidemic.

those who are older than 15 years [8]. Furthermore, a longitudinal study in China revealed that despite treatment with praziquantel, re-infection rates also remain high among children and young adolescents [9]. The national survey conducted in China in 2006 indicated that 49.3% of acute schistosomiasis infection were among those who were 7–18 years of age [10].

The spread of schistosomiasis is essentially behavior-related, because humans can only be infected via contact with snail-conditioned water [11]. Many environmental and socioeconomic conditions can influence the spread of schistosomiasis, such as raining climate, playing in the water as part of children’s daily activities, agricultural economy exposing parents and children in infested water, lack of education and income, however the most modifiable risk factor for schistosomiasis infection is behavior [12–14].

Since 2005, rigorous and comprehensive measures have been taken to control the epidemic of schistosomiasis in China, including the control of snails and snail-conditioned water, improving sanitation by supplying tap water, replacement of bovine with machines for farming, and patient treatment [15–17]. However, some challenges still exist for the implementation of these measures in some rural areas, such as farm land unsuitable for tractor farming, economical considerations of bovines beyond their use in farming and low drug efficacy [18,19]. Therefore, in this case, behavioral prevention such as avoiding contact with snail-conditioned water or taking protective measures is much more important for blocking the transmission of schistosomiasis. However, behavioral prevention has not been emphasized, particular in adolescents. An observational study in rural Brazil indicated that among 160 children participants, 96 had contacted with water in a week (3.2 contacts per person per day), and 64% of the contact where in snail-conditioned water [12]. Furthermore, a study in Zimbabwe reported that 87.9% of students do not know the appropriate protective behavioral measures for schistosomiasis prevention [20]. One study along the Yangtze River in China indicated that among young fishermen, 56.8% do not use protective measures correctly [21]. Findings from these studies strongly suggest the need to enhance behavioral preventive measures in the population of adolescent.
Materials and Methods

Ethics statement
The survey protocol was approved by Institutional Review Board at Wuhan University, China. The written consent was obtained from all students who participated in the study and their parents or guardians.

Participants and sampling
Data were collected between September and October 2013. Participants were students attending middle school at grade 1 through grade 3. Schools were selected from a high epidemic rural area in Hubei Province, China. Hubei is located in central China, it represents one of the provinces with the highest incidence rates (1.01%) of schistosomiasis and the largest number of at-risk population totaling 9.78 million [44]. Data from Hubei Provincial Center for Disease Control and Prevention (CDC) indicate that the number of middle school students with schistosomiasis accounts for 51.87% of the total infections [44].

Participants were sampled using a three-step stratified cluster sampling method. In step I: The total 41 epidemic counties in Hubei Province were divided into two strata, stratum one consisting of 19 counties with stool positive rates 1–5%, and stratum two consisting of 22 counties with stool positive rates <1% [45]. Two counties were randomly selected from each stratum, yielding a total of four counties. In step II: two townships were randomly selected from each of the four selected counties in the Step I, yielding a total of eight townships. Within each of the eight selected township, one school with middle school students were randomly selected and invited to participate. In step III: Students in middle school grades 1 to 3 in the participating schools were randomly sampled by class with three classes per grade, yielding a total of 72 classes covering grades 1 to 3 from all the eight participation schools.

All the students in the sampled classes were invited to participate and no student refused to participate. Among the total 2,796 participants who provided data, 274 (9.80%) who responded negatively to the question, “Do you know what is schistosomiasis?” were excluded. Among the remaining 2,522 participants, 284 (10.20%) were excluded because of missing data on key variables (age, gender, perceptions of harm from schistosomiasis), yielding a final sample of 2,238 (80.0%). There was no significant difference in the key study variables among those who were excluded and those included in the study.
Table 1. Characteristics of the study sample.

| Variables                        | Male         | Female        | Total         |
|----------------------------------|--------------|---------------|---------------|
| **Total, n (%)**                 | 1138 (50.85) | 1100 (49.15)  | 2238 (100.00) |
| **Chronological age**            |              |               |               |
| Mean (SD)                        | 13.22 (1.12) | 13.03 (1.07)  | 13.13 (1.10)  |
| **School grade, n (%)**          |              |               |               |
| Year 1                           | 359 (31.55)  | 339 (30.82)   | 698 (31.19)   |
| Year 2                           | 415 (36.46)  | 410 (37.27)   | 825 (36.86)   |
| Year 3                           | 364 (31.99)  | 351 (31.91)   | 715 (31.95)   |
| **If single child, n (%)**       |              |               |               |
| Yes                              | 702 (61.69)  | 500 (45.45)   | 1202 (53.71)  |
| No                               | 436 (38.31)  | 600 (54.55)   | 1036 (46.29)  |
| **Father’s education**           |              |               |               |
| Primary or less                  | 160 (14.06)  | 160 (14.55)   | 320 (14.30)   |
| Middle school                    | 742 (65.20)  | 719 (65.36)   | 1461 (65.28)  |
| High school or more              | 236 (20.74)  | 221 (20.09)   | 457 (20.42)   |
| **Mother’s education**           |              |               |               |
| Primary or less                  | 223 (19.60)  | 241 (21.91)   | 464 (20.73)   |
| Middle school                    | 705 (61.95)  | 672 (61.09)   | 1377 (61.53)  |
| High school or more              | 210 (18.45)  | 187 (17.00)   | 397 (17.74)   |

Data collection

Access to each sampled school was obtained from the school administration with the assistance of the local Anti-Schistosomiasis Stations in the sampled county. Data were collected in the classroom settings using the pencil-paper questionnaires. We developed the questionnaire specifically for this study. The developed questionnaire was pilot-tested before it was finalized for the data collection. It took approximately 20 minutes for most students to complete the survey.

The survey was administrated by eight trained data collectors. These data collectors were graduate students from School of Public Health, Wuhan University. To reduce data-collector bias, these graduate students received two-day training. To facilitate completion of the questionnaire, the eight trained data collectors each were assisted by one staff from the local county Anti-Schistosomiasis Stations who was familiar and had good working relationship with the sampled school and students. The staffs from the local Anti-Schistosomiasis Station were responsible to gather the students in a designate classroom. The trained data collectors collected the parental permits and students’ informed consents first and then distributed the questionnaires to individual students. The survey was anonymous and confidential. The students were asked to complete the questionnaires independently. They were also allowed to skip questions they did not want to answer. After a student completed the survey, he or she was instructed to hand in the questionnaire to the data collector.

Measures

Knowledge of schistosomiasis. Knowledge of schistosomiasis was assessed using an 8-item scale. These items assess whether a student knows if humans can be infected with schistosomiasis by making contact with snail-conditioned water, whether they knew the routes of transmission, intermediate host, animals that may be infected, the negative health consequence of chronic and advanced schistosomiasis, and children’s infection. Cronbach’s alpha of the knowledge scale was 0.66. Participants earned one point score for each correct answer to the 8 questions and the total score was computed such that larger scores indicated higher levels of knowledge regarding schistosomiasis infection.

Awareness of schistosomiasis and exposure to snail-conditioned water. Participants were asked how frequently they thought about schistosomiasis infection before they were exposed to snail-conditioned water in the past 3 months (awareness), responses were coded as (0 = never, 1 = occasionally, 2 = often, and 3 = always). Frequency of exposure to snail-conditioned water in the past 3 months was assessed as: 0 = never if reported “never contacted with snail-conditioned water in the past 3 months”; 1 = less than once a month if reported exposure of “less than one time per month”; 2 = monthly if exposed “1–3 times per month”, and 3 = weekly if exposed “once a week or more”.

Previous protective behaviors and future behavioral intentions. Participants were asked how frequently they took preventive measures for schistosomiasis (0 = never, 1 = occasionally, 2 = often, and 3 = every time) when they made contact with an infested water in the past 3 months and the past 6 months (protective behavior). Participants were also asked to rate their intentions to engage in protective behaviors against schistosomiasis in the next 3 months and next 12 months (behavior intention) using two questions. (1) “I am sure I will not make contact with snail-conditioned water in the next three months and next 12 months.” and (2) “If I have to make contact with snail-conditioned water in the next 3 months and next 12 months, I am sure I will take protective measures.” A 5-point Likert scale was used to assess the two questions with options of 1 = very unlikely to 5 = very likely. Mean scores of the two questions were computed for modeling analysis.

The Schistosomiasis PMT Scale. We developed the Schistosomiasis PMT Scale for this study through team effort. With the coordination of the Principal Investigator Shiyue Li,
team members proposed a number of items for each of the seven PMT subconstructs through literature review and brainstorming. Group discussion was followed to select items. Developing the PMT scale, we considered (a) face validity – different items for each subcontract must all be directly related to that construct; (b) balanced items by subcontract – similar number of items for each of all the subconstructs; (c) maximization of Chronbach alpha coefficient as a reliability measure.

The final version of PMT scale consists of 20 items assessing the seven PMT subconstructs. (1) The vulnerability was defined as perceived likelihood to be infected by schistosomiasis and was assessed using three items (Cronbach $\alpha = 0.82$). (2) The severity was defined as perceived negative consequences from schistosomiasis and was measured with three items (Cronbach $\alpha = 0.48$). (3) The intrinsic rewards was defined as perceived physical and psychological benefits from playing with (snail-conditioned) water and was assessed using three items (Cronbach $\alpha = 0.75$). (4) The extrinsic rewards was defined as perceived social benefits from playing with (snail-conditioned) water, and was assessed using three items (Cronbach $\alpha = 0.79$). (5) The response efficacy was defined as the perceived effectiveness of preventive measures in protecting a person from schistosomiasis infection, and was assessed using three items (Cronbach $\alpha = 0.63$). (6) The self-efficacy was defined as personal beliefs in one’s own ability to adopt specific protective behaviors against schistosomiasis and was assessed using three items (Cronbach $\alpha = 0.71$). And, (7) The response costs was defined as perceived costs incurred by adapting any protective behaviors, and was assessed using two items (Cronbach $\alpha = 0.69$).

The 20 individual PMT items were assesses using the 5-level response scale with 1 = “definitely agree” to 5 = “definitely disagree”. We purposefully put the negative responses before the positive responses to avoid cohesive answers. Item scores were recoded such that higher scores indicating more agreement to the individual statements. Mean scores were computed for individual subconstructs for statistical analyses.

Demographic variables. Demographic data included chronological age (in years), gender (male and female), school grade (grade 1, grade 2, grade 3), if they were a single child (yes/no), parental education (middle school or less, high school, college or more). In addition to describing the study sample, these variables were used in multivariate analysis.

Data processing and statistical analysis
Survey data were manually entered into a computer after quality check using the EpiData software. The double-entry protocol was imposed to minimize data-entry errors. Discrepancies from double entries were resolved by consulting the hardcopies of data.

| Items | Male | Female | Total |
|-------|------|--------|-------|
| **Schistosomiasis knowledge** | | | |
| Scale score, Mean (SD) | 6.66 (1.62) | 6.59 (1.57) | 6.63 (1.59) |
| **Awareness of schistosomiasis before exposure to epidemic water, n (%)** | | | |
| Never | 158 (13.88) | 98 (8.91) | 256 (11.44) |
| Occasionally | 170 (14.94) | 120 (10.91) | 290 (12.96) |
| Often | 81 (7.12) | 55 (5.00) | 136 (6.07) |
| Always | 729 (64.06) | 827 (75.18) | 1556 (69.53) |
| **Frequency of exposure to snail-conditioned water, last 3 months, n (%)** | | | |
| Weekly | 46 (4.04) | 19 (1.73) | 65 (2.90) |
| Monthly | 38 (3.34) | 29 (2.63) | 67 (3.00) |
| Less than once a month | 97 (8.53) | 45 (4.09) | 142 (6.34) |
| Never | 957 (84.09) | 1007 (91.55) | 1964 (87.76) |
| **Frequency of exposure to snail-conditioned water, last 6 months, n (%)** | | | |
| Weekly | 45 (3.95) | 46 (4.18) | 91 (4.07) |
| Monthly | 38 (6.68) | 58 (5.27) | 134 (5.98) |
| Less than once a month | 187 (16.44) | 152 (13.82) | 339 (15.15) |
| Never | 830 (72.93) | 844 (76.73) | 1674 (74.80) |
| **Engaging in protective behavior, last 3 months, n (%)** | | | |
| Never | 165 (14.50) | 113 (10.27) | 278 (12.42) |
| Occasionally | 104 (9.14) | 83 (7.55) | 187 (8.36) |
| Often | 71 (6.24) | 42 (3.82) | 113 (5.05) |
| Every time | 798 (70.12) | 862 (78.36) | 1660 (74.17) |
| **Engaging in protective behaviors, last 6 months, n (%)** | | | |
| Never | 159 (13.97) | 119 (10.82) | 278 (12.42) |
| Occasionally | 129 (11.34) | 84 (7.64) | 213 (9.52) |
| Often | 96 (8.53) | 46 (4.18) | 142 (6.34) |
| Every time | 764 (67.14) | 851 (77.36) | 1615 (72.16) |

doi:10.1371/journal.pntd.0003246.t002
Descriptive statistics were used to summarize the sample characteristics. Cronbach alpha was computed to assess the reliability of the PMT subconstructs and other scale measures. Pearson correlation coefficients were computed to assess the relationship among the variables for structural equation modeling analysis. A path modeling approach was used to assess the proposed structural relationship among the PMT subconstructs and other variables. In conducting the path modeling analysis, data-model fitting was assessed using the following four indices: GFI (≥0.9), CFI (≥0.9), RMSEA (<0.05) and Chi-square/df (<2) [41]. Statistical analyses were completed using the software SAS version 9.2 (SAS Institute Inc. Cary, NC).

**Results**

**Sample characteristics**

The demographic characteristics of the study sample are displayed in Table 1. Among the total 2,238 students, 1,138 (51%) were male, 31% were in grade one, 37% were grade two, 32% were in grade three, 54% reported that they were a single child in their family. Mean age of the sample was 13 years (SD = 1.1). Most participants reported their parental and maternal educational level to be middle school level, 66% and 62% respectively.

Knowledge and awareness of *schistosomiasis* and exposure to snail-conditioned water

The mean score of *schistosomiasis* knowledge is 6.63 (SD = 1.59) with no significant gender differences (t = 0.97, p = 0.33; Table 2). Approximately 70% of participants reported they were always aware of *schistosomiasis* before exposure to the epidemic water. Only 6% of the participants reported frequency of weekly or monthly prior exposure to snail conditioned water. Finally, 74% of participants reported that they engaged in *schistosomiasis* protective behaviors every time when making contact with snail-conditioned water in the past three months.

Intention to take protective measures

As shown in Table 3, approximately 6.71% and 7.10% of respondents reported that they are either unlikely or very unlikely to avoid contacting with snail conditioned water in the next 3 and 12 months, while 6.84% and 7.77% reported that they are either unlikely or very unlikely to use protection if they make contact with a snail-conditioned water in the next 3 and 12 months respectively.

Psychometric characteristics of the *Schistosomiasis* PMT scale

The mean and standard deviation of each item in *Schistosomiasis* PMT scale are presented in Table 4. The item to total
correlations ranged from 0.06 to 0.50, Cronbach’s alpha coefficient >0.7 among four of the seven PMT subconstructs and Cronbach’s alpha coefficient = 0.76 for the overall PMT Scale.

Association between the PMT constructs and behavior measures

Data in Table 5 indicated that (1) all the four predictor variables (knowledge, awareness, prior exposure and engagement in protective behaviors) were intercorrelated at p <0.05 or p <0.01 level. (2) All the seven PMT subconstructs were significantly intercorrelated with each at p<0.05 or 0.01 level with one exception between severity and extrinsic rewards (p>0.05). (3) Five of the seven PMT subconstructs (e.g., vulnerability, intrinsic rewards, extrinsic rewards, self-efficacy and response efficacy) were significantly associated with the four predictor variables (e.g., knowledge, awareness, prior exposure to snail-contained water, and prior engagement in protective behavior). Among the remaining two subcontracts, severity was significantly associated with prior engagement in protective behavior and future behavior intentions, response efficacy was significantly associated with knowledge and future behavior intentions. (4) The seven PMT subconstructs and the four predictor variables were all significantly associated with intention to engage in protective behaviors (p<0.01 for all).

Results from the structural equation modeling analysis

Results in Figure 2 partially support the proposed structural association that schistosomiasis knowledge, awareness, and engagement in protective behavior each are associated with PMT constructs, which in turn are associated with behavior intentions. Our data fit the hypothesized model well (GFI = 0.98, CFI = 0.93, RMSEA = 0.06, Chi-square/df = 8.6). The estimated parameters indicate that the four predictor variables each were significantly associated with at least two of the seven PMT subconstructs at p<
Discussion

As a social cognitive conceptual framework, the Protection Motivation Theory (PMT) has been widely used in predicting health behaviors [46,47] and in guiding research to devise intervention programs for purposeful behavior change [36–38]. This is the first study to investigate the applicability of PMT in understanding the schistosomiasis protective behavior among middle school students in rural China. This Schistosomiasis PMT Scale has adequate reliability with Cronbach’s alpha coefficients greater the 0.7 (considered as good) for the overall scale and for most of its subconstructs. The PMT Scale also has adequate validity because in addition to predicting behavioral intentions, the seven PMT subconstructs were associated with all the predictor variables used in this analysis, including previous use of protective measures, knowledge of schistosomiasis, awareness of schistosomiasis infection, and previous exposure to risk factors.

Despite rapid economic development, schistosomiasis remains a public health challenge in many epidemic regions, particularly the rural areas in China and many other developing countries [48–50]. Findings of this study provide evidence supporting the significance of the PMT, a US-developed theory in guiding behavioral research and intervention, for schistosomiasis control in China. To our knowledge, PMT theory can be considered as an expansion of Knowledge-Attitude-Practice (KAP) Theory to encompass such components as cognitive appraisal of the risks of schistosomiasis infection, and benefits from using protection and self-coping strategies. In addition to information-based education and skills, PMT emphasizes training for decision making by assessing the risks of diseases and benefits from protection, and motivate participants to take protective actions against diseases.

Consistent with the PMT theory, results from correlation and structural equation modeling analysis of this study indicate that schistosomiasis knowledge, awareness of infection, prior exposure to snail-contained water, and engagement in protective behaviors are associated with various PMT constructs. This finding suggests that in addition to the cognitive components related to PMT, intervention programs may benefit by considering previous knowledge, experience and cognition of schistosomiasis [51]. Relative to students with previous knowledge and protective experience, more efforts may be needed to encourage naive youth to use protection against schistosomiasis.

Another key finding of this study is that both the PMT threat appraisal pathway (e.g., the severity and intrinsic rewards) and the PMT coping appraisal pathway (e.g., self-efficacy) are associated with intention to engage in protective behaviors. The role of coping appraisal (particularly self-efficacy) has been reported in intervention studies focused on HIV risk behavior prevention [36–38], and there is a lack of data supporting the role of the threat appraisal. One reason for our findings is that compared to HIV related behaviors (e.g., sexual initiation, use of a condom during sex, use of alcohol and drugs), schistosomiasis-related behavior are less likely to be affected by situational and emotional factors.

| Variable | Mean (SD) | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|----------|----------|---|---|---|---|---|---|---|---|----|----|----|
| 1. Severity | 3.34 (0.72) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 2. Vulnerability | 3.65 (1.71) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 3. Intrinsic rewards | 0.19** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** | 0.09** |
| 4. Extrinsic rewards | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** | 0.20** |
| 5. Response efficacy | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** |
| 6. Self-efficacy | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** |
| 7. Response cost | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** | 0.19** |
| 8. Awareness consideration | 2.01 (1.36) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 9. Knowledge | 6.03 (1.59) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 10. Prior exposure | 2.79 (0.63) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 11. Protective behavior | 2.41 (1.07) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 12. Behavior intention | 4.17 (0.97) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |

Note: *p<0.05, **p<0.01.
Students may have adequate time to think about the threats of schistosomiasis and the pros and cons of using or not using protection. If this is the case, we can anticipate that a PMT-based intervention could be more effective to encourage protective behaviors against schistosomiasis than HIV if both the threat appraisal and the coping appraisal are emphasized.

From an applied perspective, the findings from the study suggest that several variables (i.e. severity, intrinsic rewards and self-efficacy), especially self-efficacy, should be targeted in schistosomiasis intervention programs for adolescents in order to increase their behavior intentions. First, adolescents' belief in their ability to avoid contact with snail-conditioned water despite barriers (i.e. self-efficacy) should be improved through providing positive coping messages to enhance their confidence regarding protective behaviors and their belief that protective behaviors provides health benefits. Second, realistic information about disease severity should be concentrated on to increase their perceived level of fear about the disease for promotion acceptance of the proposed adaptive behavior or intention.

This study has some limitations. First, data used for this study was collected through a cross-sectional survey. Therefore the observed relationship between PMT subconstructs severity and other variables need to be verified through longitudinal studies. Second, although overall the Schistosomiasis PMT scale has adequate reliability, the Chronbach’s alpha coefficients were less than satisfactory for two PMT subconstructs severity (alpha = 0.48) and response efficacy (alpha = 0.63). These relatively low alpha coefficients suggest the need for further work to improve the reliability of these two measures. Despite the limitations, this study is the first to systematically test the utility of a US-developed behavioral theory in describing schistosomiasis behavior among middle school students in China. Findings from this study add novel data supporting more effective schistosomiasis prevention interventions.

Supporting Information

Checklist S1 STROBE Checklist.

Acknowledgments

We would like to thank the study participants and their families, and the staff from the local Anti-Schistosomiasis Station and all data collectors.

Author Contributions

Conceived and designed the experiments: SL XC BY HY. Performed the experiments: HX SL MG HY. Analyzed the data: HX SL XC BY MG HY CNO. Wrote the paper: HX SL XC BY MG HY CNO.

Figure 2. Structural equation modeling of schistosomiasis knowledge, prior exposure, awareness, protective behavior, schistosomiasis PMT constructs and behavior intention. The data-model fit indices: GFI = 0.98, CFI = 0.93, RMSEA = 0.06, Chi-square/df = 8.6. **, p<0.01 and *, p<0.05. doi:10.1371/journal.pntd.0003246.g002
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