Preplanned Studies

Attitudes as a Critical Mediator Between Schistosomiasis Knowledge and Practices Among Students, with Implications for Behavior Change Interventions — Pemba Island, Zanzibar, Tanzania, 2024

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Summary

What is already known about this topic?

Despite mass drug administration (MDA) programs in Zanzibar, schistosomiasis transmission persists due to behavioral gaps, and prior studies in sub-Saharan Africa consistently reveal significant knowledge-practice disparities where improved knowledge alone fails to translate into preventive behaviors.

What is added by this report?

We quantified that attitudes are a pivotal mediator, accounting for 68.35% of knowledge's effect on schistosomiasis prevention practices among Zanzibari students. This finding, from a 2024 cross-sectional study on Pemba Island, shifts the focus from knowledge dissemination alone to attitude transformation as the central strategy for effective behavior change interventions.

What are the implications for public health practice?

Public health interventions must prioritize attitude transformation (mediated 68.35% of knowledge's effect on practices) through education (e.g., peer role-playing) while concurrently improving WASH infrastructure, as attitudes are the critical pathway to behavior change in endemic communities.

ABSTRACT

Introduction: Despite mass drug administration (MDA) in Zanzibar, schistosomiasis persists because of behavioral gaps. This study quantified the mediating role of attitudes in bridging knowledge and preventive practices among schoolchildren, addressing the critical evidence gap in behavioral change (BC) interventions.

Methods: A school-based cross-sectional study (N=390) was conducted on Pemba Island (2024), using cluster sampling. Knowledge, attitudes, and practices (KAP) surveys were combined with urinary egg detection for parasitological confirmation. Statistical analyses included regression to identify influencing factors (P<0.05) and mediation analysis to quantify the role of attitude in the knowledge-practice pathway.

Results: The infection rate was 12.05%. Mean scores were 6.89±1.50 (out of 10) for knowledge, 41.40±9.77 (out of 55) for attitudes, and 19.28±2.78 (out of 30) for practices. Regression analysis identified sex, grade level, access to tap water, and opportunities for water contact as influencing factors (P<0.05). Critically, attitudes mediated 68.35% of the total effect of knowledge on practices, confirming their pivotal role.

Conclusion: These findings highlight the importance of accurate knowledge and positive attitudes towards promoting preventive practices among students. This study thus proposes a community health volunteer (CHV)-led intervention that integrates attitude-focused education (e.g., peer role-playing) with WASH infrastructure improvements.

Schistosomiasis remains highly endemic in tropical and subtropical regions, affecting about 240 million people globally, with 779 million at risk (*1*–*2*). In Africa, 91.30% of cases require preventive chemotherapy (PC) (*3*). The World Health Organization's (WHO) *2021–2030 Neglected Tropical Diseases (NTD) roadmap* targets interruption of transmission and elimination as a public health problem (*4*–*5*), posing major challenges for endemic regions like Zanzibar. Pemba Island, about 30 km off mainland Tanzania (*6*), harbors abundant *Bulinus*

snails, the main intermediate hosts for *Schistosoma haematobium*. Among students in Africa, schistosomiasis causes significant morbidity, with symptoms such as fever, abdominal pain, diarrhea, and hematuria (*7*), leading to discomfort, impaired well-being, and frequent school absenteeism.

The WHO 2021–2022 guidelines prioritize interrupting schistosomiasis transmission through expanded PC for all age groups, together with the implementation of integrated multisectoral approaches. Although the guidelines target the entire population, school-aged children remain at the highest risk of infection and are the most accessible for intervention in resource-limited settings, such as Zanzibar. Their frequent contact with water makes them more vulnerable to infection, and they also serve as important bridges for disseminating health knowledge within their households, thereby influencing protective behaviors at the family level. Therefore, behavior-centered interventions targeting this group are particularly critical for the effective implementation of the guidelines. A comprehensive review by Trippler et al. highlighted the importance and impact of health education interventions (*8*). However, in Zanzibar, health education programs have been implemented only sporadically and with insufficient resources, reflecting persistent implementation challenges in resource-constrained settings. Against this background, this study focused on school-aged children in Zanzibar, aiming to identify key risk factors affecting the adoption of protective behaviors against schistosomiasis and to provide evidence for the development of targeted behavioral intervention strategies.

The study was conducted from January to March 2024 at Chambani Primary School on Pemba Island. A face-to-face questionnaire survey and urine schistosome egg detection were conducted via cluster sampling of fifth- and sixth-grade students in primary schools, carried out by trained community health volunteers (CHVs). Participants Inclusion Criteria: 1) Students in the fifth and sixth grades, and 2) The students' parents/guardians provided written informed consent; 3) The students were healthy and willing to provide urine samples. Urine samples were collected from participating students at the survey school. The teachers monitored the process and ensured that all the students followed the instructions carefully. The collected urine samples were sent to the China-aided Zanzibar Pathogen Biology Laboratory located on Pemba Island, Zanzibar, Tanzania. Filtration technology with nylon, paper, or polycarbonate membranes was used to filter urine. The material left on the filter membrane was then examined under a microscope. If eggs were present, the number of eggs on the entire filter membrane was recorded, and the result was considered positive (*9*). All participants received MDA with praziquantel at identical frequencies and timings before the survey, ensuring that the observed KAP variations were not confounded by differential chemotherapy exposure.

A structured questionnaire was developed in English and translated into Swahili (Supplementary Material, available at https://weekly.chinacdc.cn/). A pilot survey was conducted with a small group of students, and revisions were made. The questionnaire comprised four parts. Part A collected the basic demographic information. Part B consisted of 10 multiple-choice questions to assess basic knowledge of schistosomiasis (*10*–*12*). Each correct answer was given a score of 1 point, for a total of 10 points. Part C contained 11 attitude questions rated on a five-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) (*10*–*11*), with a total possible score of 55. Part D comprised 10 practice-related questions . The first three questions were scored 1–3 for "always," "sometimes," and "never," respectively, and the remaining seven questions were reverse-scored, with a total possible score of 30. Exploratory factor analysis confirmed the construct validity of the questionnaire's attitude (Section C) and behavior (Section D) scales, with satisfactory reliability indices: a Cronbach's alpha of 0.76, a KMO value of 0.79, and a significant Bartlett's test of sphericity value of 2818.72 (P<0.001).

Data were analyzed using SPSS (version 26.0.0.0, IBM Corp., Armonk, NY, USA). Differences were evaluated using independent sample t-tests and analysis of variance (ANOVA). The relationships were assessed using Pearson's correlation analysis. Multiple linear regression models were used to analyze these factors. The significance level was set at α =0.05 (two-tailed).

Among the 390 students surveyed, 176 (45.13%) were male, and 214 (54.87%) were female. The average age of the participants was 13±1.47 years. In total, 212 (54.36%) and 178 (45.64%) students were in the fifth and sixth grades, respectively. The average number of people per household was 8, ranging from 2 to 16 individuals. More than two-thirds of the students' parents were engaged in farming or fishing; specifically, 72.56% of fathers and 74.36% of mothers worked in these fields. Most students had access to tap water (84.10%) and toilets (92.05%) near their homes. Additionally, 76.92% of the participants lived near

natural water sources (Table 1). The prevalence of urinary schistosomiasis was 12.05%, with 47 positive cases in 30 boys (63.83%), and 17 girls (36.17%).

The study showed that only 3.80% of the students correctly identified schistosomiasis types, and 24.60% understood that contact with infected urine could transmit *Schistosoma haematobium*. Positive attitudes emerged: 65.10% recognized the disease's health

TABLE 1. Results of the analysis of influencing factors on knowledge, attitudes, and practices regarding schistosomiasis.

Variable/Category	Knowledge score		Attitude score		Practice score	
	Mean±SD	*P*	Mean±SD	*P*	Mean±SD	*P*
Gender						
Male	7.09±1.53	0.02	42.33±9.87	0.13	19.09±2.95	0.21
Female	6.73±1.46		40.71±9.67		19.44±2.63	
Grade						
Fifth grade	6.31±1.63	<0.001	37.31±9.04	<0.001	18.86±2.92	0.00
Sixth grade	7.58±0.94		46.26±8.27		19.79±2.53	
Household size						
1–10 people	6.94±1.53	0.16	41.22±9.73	0.46	19.32±2.80	0.79
11–20 people	6.67±1.38		42.16±9.98		19.21±2.70	
Father's occupation						
Farmer/fisherman	6.85±1.58	0.02	40.97±9.46	0.15	19.40±2.83	0.20
Worker	6.82±1.37		41.70±12.17		19.59±3.09	
Self-employed worker/businessman	7.13±1.28		44.97 ±9.42		18.61±2.40	
Teacher	7.00±1.18		43.73±7.77		18.55±2.54	
Government staff	7.27±1.01		43.91 ±8.73		17.55±0.93	
Medical staff	–		–		–	
Unemployed	6.40±1.14		36.40±8.82		18.80±2.28	
Others	7.80±0.45		35.20 ±8.64		20.20±1.48	
Mother's occupation						
Farmer/fisherman	7.00±1.49	0.01	41.55±9.02	0.42	19.43±2.84	0.24
Worker	6.60±1.67		42.00±12.30		18.74±2.59	
Self-employed Worker/businessman	6.67±1.39		40.11 ±9.58		18.33±2.32	
Teacher	6.53±1.38		39.53±12.31		18.76±2.43	
Government staff	8.00±1.00		42.67±11.50		18.00±1.73	
Medical staff	6.00±0.00		55.00±0.00		20.50±0.71	
Unemployed	5.86±1.17		38.50±14.47		19.71±3.29	
Others	9.00±1.41		47.00 ±1.41		22.00±1.41	
Whether they have access to tap water near their residence						
Yes	6.88±1.50	0.81	41.90±9.92	0.02	19.29±2.81	0.97
No	6.94±1.50		38.74±8.52		19.27±2.66	
Whether they have access to toilets near their residence						
Yes	6.90±1.48	0.65	41.63±9.59	0.11	19.29±2.81	0.90
No	6.77±1.73		38.71±11.48		19.23±2.50	
Whether they have access to water sources near their residence						
Yes	7.01±1.49	0.00	42.16±8.76	0.02	19.31±2.74	0.76
No	6.49±1.46		38.87±12.29		19.21±2.94	

Note: "–" means data not applicable.
Abbreviations: SD=standard deviation.

threat, 80.40% were willing to seek medical help for symptoms, 77.70% took protective measures, such as wearing gloves and rubber shoes during water activities, and 84.10% desired health education. The study identified misconceptions, with 30.50% falsely linking untreated drinking water to infection and 17% doubting the effectiveness of snail control. In practice, 55%–60% engaged in water-related activities in schistosomiasis-endemic environments, 68.20% never used protective measures, 80.30% never played with classmates known to have schistosomiasis, and 62.10% did not assist or correct the behaviors of classmates with schistosomiasis. Alarmingly, 73.80% delayed seeking treatment, and 65.40% avoided medication post-diagnosis.

Independent-sample t-tests and ANOVA revealed significant differences in the scores across the following categories: While age was recorded (mean: 13±1.47 years), subsequent analysis did not identify it as a significant factor influencing knowledge scores in this cohort. The most significant variations in knowledge were associated with grade level, parental occupation, and proximity to water sources. Attitude scores varied according to grade level, availability of tap water in the vicinity, and proximity to water sources. Practice scores differed only by grade (P<0.05) (Table 1).

Multiple linear regression analysis revealed that grade level, availability of tap water in the vicinity, and proximity to water sources were the influencing factors for attitudes, while gender and grade level were the influencing factors for practices (P<0.05) (Table 2).

Correlation analysis revealed that knowledge was significantly correlated with attitudes (r=0.32, P<0.001) and prevention practices (r=0.12, P<0.05). A one-SD increase in knowledge levels predicted a 32.40% improvement in attitude scores. Notably, the attitude-practice correlation (r=0.14, P<0.01) was weaker than the knowledge-attitude relationship (Supplementary Table S1, available at https://weekly.chinacdc.cn/).

The structural equation model demonstrated full mediation; schistosomiasis-related knowledge influenced preventive practices through attitude. Knowledge demonstrated a substantial positive effect on attitudes (β=2.11, P<0.01), while attitudes subsequently predicted practices (β=0.03, P<0.05). Notably, the direct effect of knowledge on practices became non-significant after accounting for attitudes (β=0.15, P>0.05). Bootstrap analysis confirmed that attitudes mediated 31.70% of knowledge's total effect on practices [indirect effect=0.07, 95% confidence interval (*CI*): 0.01, 0.14], with a significant total effect (effect size=0.22, 95% *CI:* 0.03, 0.40), but a non-significant direct effect (95% *CI*: 0.04, 0.34) (Supplementary Table S2, Supplementary Figure S1, available at https://weekly.chinacdc.cn/).

DISCUSSION

A 12.05% schistosomiasis prevalence among the students suggests moderate endemicity per WHO guidelines (≥10%), requiring control measures (5). Moreover, this analysis revealed notable variations among students in their knowledge of schistosomiasis, attitudes towards prevention, and behavioral changes (BC). Only 50% demonstrated correct knowledge about urogenital schistosomiasis; however, 80.30% practiced social distancing (avoiding contact/helping infected individuals), revealing disease misconceptions

TABLE 2. Results of the Multivariate Analysis on knowledge, attitudes, and practices Regarding Schistosomiasis.

Variable		Standardization coefficients		*P*	95% *CI*
		β	*t*		
Knowledge score	Constant		11.44	<0.001***	[5.76, 8.15]
	Grade	0.32	7.17	<0.001***	[0.71, 1.24]
Attitude score	Constant		9.06	<0.001***	[29.12, 45.26]
	Grade	0.45	9.58	<0.001***	[6.97, 10.58]
	Whether they have access to tap water near their residence	−0.10	−2.16	0.03*	[−5.09, −0.24]
	Whether there is a water source near their residence	−0.10	−2.28	0.02*	[−4.51, −0.33]
Practice score	Constant		14.62	<0.001***	[16.55, 21.69]
	Gender	0.14	2.53	0.01*	[0.17, 1.35]
	Grade	0.16	3.12	0**	[0.34, 1.49]

* P<0.05; ** P<0.01; *** P<0.001.
Abbreviation: *CI*=confidence interval.

and stigma. Corroborating studies from other schistosomiasis-endemic areas in sub-Saharan Africa similarly indicate that disease stigma significantly compromises treatment adherence and the effectiveness of community-based interventions. Therefore, future health education must not only disseminate accurate knowledge but also actively address stigma and promote social inclusion.

The study found that 87.20% of students said they would seek medical care for symptoms such as hematuria, yet only 34.60% of the infected patients did so. Similarly, only 26.10% of the patients sought drug treatment post-infection. This discrepancy may stem from barriers, such as distance to healthcare facilities, costs, and limited awareness (*13*). Since students rarely bear medical expenses, these factors alone may not explain their behavior. Other influences — family support, cultural beliefs, and access to reliable health information — should also be considered. Although 77.70% recognized the need for protective measures like gloves and rubber shoes during water activities, adherence remained low at 68.20%. Similarly, 72.30% correctly identified *Bulinus* snails as key hosts for *Schistosoma haematobium*, but many students frequently interacted with water bodies potentially harboring these snails. These survey results align with studies conducted in Mozambique and Côte d'Ivoire (*14*–*15*) and may be influenced by local factors, including inadequate sanitation facilities and sociocultural aspects. For example, male students face higher risks of grass cutting, livestock herding, and fishing. Avoiding contact with contaminated water is critical for preventing infection, particularly — through improved sanitation infrastructure. Interventions should reflect local sociocultural and resource contexts. Bridging the knowledge-practice gap demands targeted education, behavioral programs, enhanced infrastructure and accessible healthcare in high-risk areas.

The finding that attitudes mediate 68.35% of knowledge's total effect on preventive practices underscores attitudes as key drivers of BC. Knowledge alone is insufficient; interventions must actively reshape perceptions and emotional responses to bridge the knowledge-practice gap. Therefore, BC interventions must prioritize attitude transformation through interactive, culturally resonant education (e.g., peer role-playing and case studies) led by trusted CHVs. These efforts should be integrated with tangible WASH infrastructure improvements (e.g., expanding tap water access) to address practical barriers and reinforce positive beliefs. Interventions must also be tailored by grade level: for higher grades, deepening the scientific understanding of etiology and prevention, and for lower grades, focusing on foundational hygiene and fear reduction. By leveraging CHVs to bridge formal education with community implementation and continuously measuring attitude shifts as key outcomes, programs can effectively convert knowledge into sustained protective practices, thus closing the critical knowledge-attitude-practice gap identified in this study.

The study is subject to at least three limitations. First, the small sample size may restrict the statistical power of the analyses and limit the generalizability of the results to broader populations. Second, reliance on self-reported data introduces the potential for response bias, such as social desirability or recall inaccuracies, which may affect the accuracy of behavioral measures. Finally, insufficient consideration of seasonal factors could overlook temporal variations in transmission risk, thereby narrowing the understanding of schistosomiasis dynamics across different times of the year.

This study underscores the critical gaps in schistosomiasis awareness among post-pandemic students on Pemba Island and highlights the strategic value of integrating CHVs into health education frameworks. By leveraging the CHVs' localized expertise and community trust, interventions can bridge knowledge deficits while fostering sustainable BC. These findings align with KAP theory, emphasizing the necessity of dual-focused strategies that simultaneously strengthen disease-specific knowledge and cultivate proactive health attitudes. Future efforts should prioritize adaptable community-driven approaches to optimize prevention practices and effectively mitigate transmission risks.

Ethical Statement: Conducted within the administration of district NTD offices and approved by the Ethics Review Committee of Zanzibar (ZAMREC/002/MAY/014). Informed consent was obtained from all parents or legal guardians.

Conflicts of interest: No conflicts of interest.

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Results of the correlation analysis of schistosomiasis KAP among students.

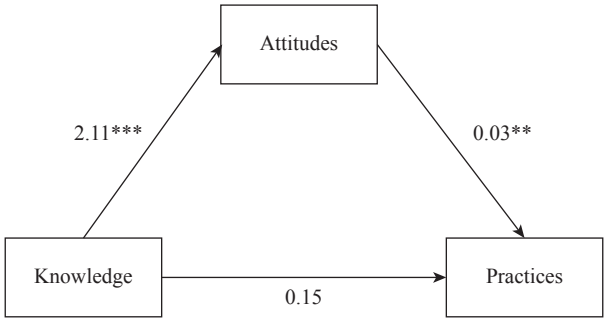
KAP	Knowledge	Attitudes	Practices
Knowledge	1		
Attitudes	0.32***	1	
Practices	0.12*	0.14**	1

Abbreviation: KAP=knowledge, attitudes, and practices;
* *P*<0.05; ** *P*<0.01; *** *P*<0.001.

SUPPLEMENTARY TABLE S2. Estimates of the mediating effects of schistosomiasis-related KAP among primary school students on Pemba Island.

Variable	Effect	BootSE	BootLLCI	BootULCI	Effect size
Total effect	0.22	0.09	0.03	0.40	
Indirect effect	0.15	0.10	−0.04	0.34	68.35%
Direct effect	0.07	0.03	0.01	0.14	31.65%

Abbreviation: KAP=knowledge, attitudes, and practices; BootSE=Bootstrap Standard Error; BootLLCI=Bootstrap Lower Limit for the Confidence Interval; BootULCI=Bootstrap Upper Limit for the Confidence Interval.



SUPPLEMENTARY FIGURE S1. The mediation model for primary school students on Pemba Island regarding schistosomiasis-related KAP.
Note: The number 2.11 represents the effect of knowledge (independent variable) on attitudes (mediator), which is significant; 0.03 is the effect of attitudes (mediator) on practices (dependent variable), controlling for knowledge, and is significant; 0.15 denotes the direct effect of knowledge (independent variable) on practices (dependent variable), controlling for attitudes.
Abbreviation: KAP=knowledge, attitudes, practices;
* *P*<0.05; ** *P*<0.01; *** *P*<0.001.