Preplanned Studies

Effectiveness of an Integrated One Health Intervention on *Schistosoma japonicum* Infection in Wild Rodents — Anhui Province, China, 2022–2024

Suying Guo[1]; Chao Lyu[1]; Lijuan Zhang[1]; Wangping Deng[1]; Jing Xu[1,#]; Shizhu Li[1]; Xiaonong Zhou[1]

Summary

What is already known about this topic?

Schistosomiasis represents a natural focal disease in which wild rodents function as critical reservoir hosts for *Schistosoma japonicum* transmission within specific endemic regions of China.

What is added by this report?

Implementation of a comprehensive 2-year One Health intervention package demonstrated a significant reduction in *S. japonicum* infection rates among wild rodents, declining from 69.15% to 22.09%, with intervention villages showing an 88.46% decrease in infection odds compared to control villages.

What are the implications for public health practice?

Integrating One Health intervention measures into schistosomiasis control programs could effectively reduce infection risk among environmental reservoir hosts and mitigate transmission risks to human populations.

ABSTRACT

Introduction: Wild rodents serve as important reservoir hosts of *Schistosoma japonicum* in certain endemic regions. Although a One Health strategy integrating human, animal, and environmental health measures has been proposed, evidence demonstrating its effectiveness in reducing wildlife reservoir infection remains limited.

Methods: A preplanned intervention study was conducted from 2022 to 2024 across 12 villages in two endemic counties of Anhui Province. Villages were assigned to receive either routine control measures or an enhanced One Health intervention package that included deratization, drone-based surveillance, microenvironment modification, and health education. Annual rodent surveys were conducted using trap-night methods, and multiple diagnostic tests were employed to detect *S. japonicum* infection.

Results: A total of 2,084 rodents were captured and examined. The *S. japonicum* infection rate in intervention villages decreased from 69.15% (278/402) at baseline to 22.09% (146/661) after two years of intervention (χ^2=230.950, *P*<0.01), whereas the infection rate in control villages increased from 39.07% (143/366) to 45.65% (299/655) (χ^2=4.138, *P*=0.04). Adjusted analysis demonstrated an 88.46% reduction in infection odds within the intervention group [adjusted odds ratio (a*OR*)=0.115, 95% confidence interval (*CI*): 0.078, 0.172].

Conclusion: A comprehensive One Health intervention package is significantly associated with reduced *S. japonicum* infection in wild rodents. Integrating rodent-targeted measures into schistosomiasis control programs may substantially decrease transmission risk and accelerate progress toward nationwide schistosomiasis elimination.

Schistosomiasis japonica is a snail-borne neglected tropical disease caused by *Schistosoma japonicum* infection, which produces complex intestinal manifestations in chronically infected individuals (*1*). Classified as a class B infectious disease in China, schistosomiasis is currently progressing toward national elimination. However, *S. japonicum* maintains a broad host range, infecting over 40 mammalian species. Among these, wild rodents have emerged as increasingly important transmission reservoirs in specific ecological settings, particularly mountainous and hilly regions where human-wildlife interfaces are common (*2*–*3*). Addressing this zoonotic transmission cycle requires interventions that span human, animal, and environmental health sectors — an approach embodied by the One Health framework (*4*). Despite growing recognition of wild rodents as key reservoir hosts, rigorous field evidence demonstrating the effectiveness of integrated control measures targeting these populations remains limited. To address this knowledge gap, we designed a preplanned intervention study to evaluate whether a comprehensive One Health package could effectively reduce *S. japonicum* infection prevalence in wild rodent populations within high-risk areas of Anhui Province, thereby mitigating spillover transmission to humans and livestock.

This study was conducted from 2022 to 2024 in two historically high-endemic counties in Anhui Province: Dongzhi County and Dangtu County. Site selection was based on a comprehensive review of recent epidemiological data, including human infection prevalence, distribution of *Oncomelania hupensis* snail habitats, and livestock density, combined with an assessment of operational feasibility. Twelve administrative villages were selected from endemic areas: six from hilly regions in Dongzhi County and six from swamp and lake regions in Dangtu County. These villages were evenly assigned to either the intervention group or the control group (three per county in each group). To minimize potential spillover effects, villages in different study groups were geographically separated. Baseline surveys were conducted in 2022, followed by implementation of intervention measures in 2023 and 2024. Control villages received only routine schistosomiasis control measures, including regular health education, screening and treatment of infected humans and livestock, and conventional molluscicide application. In addition to these routine measures, intervention villages received a comprehensive One Health intervention package beginning in January 2023 (Supplementary Table S1, available at https://weekly.chinacdc.cn/).

Annual cross-sectional surveys of wild rodents were conducted each autumn (September through November) from 2022 to 2024. In each study village, rodents were captured over three consecutive nights using the standard trap-night method. A minimum of 200 wire traps were deployed per night in *O. hupensis* snail habitats along linear transects, including irrigation ditches, field borders, and residential peripheries. All captured rodents were identified to species level. Infection with *S. japonicum* was determined using a parallel diagnostic approach comprising three methods: visual examination for adult worms in the hepatic portal and mesenteric veins, microscopic examination of liver homogenate, and Kato-Katz thick smear technique for fecal egg detection. A rodent was classified as positive if *S. japonicum* adult worms or eggs were identified by any of these methods (*5*).

Descriptive statistics were calculated to summarize baseline characteristics and annual trends in *S. japonicum* infection rates among wild rodents at the county level. Infection rates from 2023 and 2024 were pooled to represent the intervention period. Pearson's chi-square test was employed to assess changes within each group from baseline to the intervention period. To control for potential confounding from baseline prevalence differences and county-level heterogeneity, we constructed a multivariable logistic regression model. This model incorporated main effects for study group (intervention *vs*. control), time period (baseline *vs*. post-intervention), and county, as well as an interaction term between study group and time period. The exponentiated coefficient of this interaction term yields the adjusted odds ratio (a*OR*) quantifying the intervention effect. All statistical analyses were conducted using R software (version 4.3.0, The R Foundation), with two-sided P<0.05 considered statistically significant.

A total of 2,084 wild rodents were captured and examined over the three-year study period, with 1,063 from the intervention villages and 1,021 from the control villages. At baseline, the infection rate in the intervention group (69.15%, 278/402) was substantially higher than that in the control group (39.07%, 143/366) (χ^2=70.001, P<0.01). Following the two-year intervention period, the pooled infection rate in the intervention group significantly decreased to 22.09% (146/661), representing an absolute reduction of 47.06 percentage points (χ^2=230.950, P<0.01). In contrast, the infection rate in the control group significantly increased to 45.65% (299/655), representing an absolute increase of 6.58 percentage points (χ^2=4.138, P=0.04); this increase was particularly pronounced in Dangtu County (Table 1). As shown in Table 2, county type, time period, and study group were all significantly associated with *S. japonicum* infection in wild rodents. After adjusting for county-level effects and time period, the a*OR* for the intervention effect was 0.115 (95% *CI*: 0.078, 0.172), indicating an 88.46% reduction in the odds of *S. japonicum* infection among rodents in intervention villages compared to control villages following the two-year One Health intervention.

DISCUSSION

This study demonstrates that a comprehensive One Health intervention approach is significantly associated with reduced *S. japonicum* infection rates in wild

TABLE 1. Infection rates of *Schistosoma japonicum* in wild rodents across intervention and control groups, 2022–2024.

Year	Infection rate in intervention groups, % (*n*/*N*)					Infection rate in control groups, % (*n*/*N*)				
	Dongzhi County	Dangtu County	Total	X^2	*P*	Dongzhi County	Dangtu County	Total	X^2	*P*
Baseline										
2022	77.46 (268/346)	17.86 (10/56)	69.15 (278/402)	–	–	52.65 (119/226)	17.14 (24/140)	39.07 (143/366)	–	–
After intervention										
2023	36.76 (50/136)	13.42 (20/149)	24.56 (70/285)	132.672	<0.01	55.51 (141/254)	25.55 (35/137)	45.01 (176/391)	2.737	<0.01
2024	24.83 (73/294)	3.66 (3/82)	20.21 (76/376)	187.663	<0.01	46.41 (84/181)	46.99 (39/83)	46.59 (123/264)	3.555	0.06
Two-year pooled	28.60 (123/430)	9.96 (23/231)	22.09 (146/661)	230.950	<0.01	51.72 (225/435)	33.64 (74/220)	45.65 (299/655)	4.138	0.04
Total	50.39 (391/776)	11.50 (33/287)	39.89 (424/1,063)	232.228	<0.01	52.04 (344/661)	27.22 (98/360)	43.29 (442/1,021)	4.298	0.12

Note: "–" means reference.

TABLE 2. Multivariable binary logistic regression coefficients for *S. japonicum* infection in wild rodents.

Parameters	B	SE	*aOR* (95% *CI*)	*P*
County (ref: Dongzhi)	−1.328	0.116	0.265 (0.211, 0.333)	<0.01
Study group (ref: control group)	1.011	0.158	2.749 (2.016, 3.749)	<0.01
Time period (ref: baseline)	0.232	0.139	1.261 (0.961, 1.656)	0.09
Study group * time period interaction	−2.159	0.202	0.115 (0.078, 0.172)	<0.01

Abbreviation: *aOR*=adjusted odds ratio; *CI*=confidence interval.

rodent populations. These findings complement and extend prevalence data from previous rodent surveillance studies (*6*–*7*). In theory, integrating simultaneous data on snail infection rates and schistosomiasis incidence in humans and livestock would allow for a more comprehensive assessment of intervention effectiveness. However, prevalence in these hosts has remained at extremely low levels for years when measured by traditional detection methods, thereby limiting their utility for estimating environmental transmission risk. As wild animals increasingly serve as the primary reservoir hosts, surveillance and effective infection control in these populations appear crucial during the transmission interruption and post-elimination phases (*8*).

The results indicate that a targeted package of environmental, rodent-focused, and community-based measures was associated with a marked decline in rodent infection prevalence within intervention villages. In contrast, the increased prevalence observed in control villages may be explained by the limited effectiveness of routine control measures against wildlife reservoirs. This pattern underscores the persistent intensity of zoonotic transmission and suggests potential for escalation without targeted reservoir management. The observed 88.46% reduction in adjusted infection odds is notable in field-based zoonotic disease research, suggesting that the intervention may have disrupted critical links in the local transmission cycle — potentially by reducing rodent-snail habitat overlap, decreasing rodent density and infection pressure, and limiting environmental contamination with parasite eggs. However, it should be noted that potential confounders — including ecological heterogeneity, rodent species composition, and operational variations — were not explicitly controlled for, and residual confounding cannot be fully ruled out. Future studies could enhance interpretability by clarifying covariate selection and more thoroughly addressing these limitations. The increased infection rate in control villages further implies that transmission risk may continue to escalate in the absence of tailored interventions. Although rodent infection is not included as an indicator in the national criteria for schistosomiasis elimination, it can serve as a valuable risk indicator, signaling the persistence of the complete *S. japonicum* life cycle in nature. Further research is needed to clarify the spillover risk from infected wildlife populations and their role in sustaining current transmission dynamics.

This study has several important limitations. First, the non-randomized village assignment may not fully eliminate residual confounding from unmeasured ecological or epidemiological factors, despite statistical adjustment for county-level effects and baseline prevalence. Second, variations in rodent trapping efficiency and diagnostic sensitivity across sites could introduce bias into prevalence estimates, potentially affecting the magnitude of observed intervention effects. Third, the substantial baseline imbalance in infection rates between intervention and control villages (69.15% *vs*. 39.07%) complicates causal attribution of the observed decline, as regression to the mean or unmeasured site-specific factors could partially explain the differential trends. The underlying drivers of this baseline heterogeneity were not systematically investigated.

This study demonstrates that a comprehensive, integrated One Health intervention strategy can substantially reduce *S. japonicum* prevalence in wild rodent populations — a reservoir host that has proven notoriously difficult to manage. The intervention package provides an evidence-based model for schistosomiasis control in areas where wildlife reservoirs sustain ongoing transmission. For endemic regions approaching elimination or maintaining post-elimination status, public health programs should consider integrating environmental modification and targeted reservoir host management into their long-term control strategies. Successful implementation of such measures requires sustained cross-sectoral collaboration spanning health, agriculture, water resources, forestry, and natural resource management agencies. The observed prevalence increase in control villages (from 39.07% to 45.65%) underscores the critical need for proactive, ecologically informed interventions in high-risk areas to prevent transmission resurgence and accelerate progress toward national schistosomiasis elimination goals.

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Conflicts of interest: The authors declare no conflicts of interest.

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Corresponding author: Jing Xu, xujing@nipd.chinacdc.cn.

[1] National Institute of Parasitic Diseases, Chinese Center for Disease Control and Prevention (Chinese Center for Tropical Diseases Research); National Key Laboratory of Intelligent Tracking and Forecasting for Infectious Diseases; Key Laboratory on Parasite and Vector Biology, Ministry of Health; WHO Centre for Tropical Diseases; National Center for International Research on Tropical Diseases, Ministry of Science and Technology, Shanghai, China.

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. One Health intervention measures implemented in intervention and control villages, 2023–2024.

One Health Approach	Intervention Villages	Control Villages
Human Health	1. Chemotherapy 2. Common health education 3. Key population management 4. Intelligent surveillance system 5. Health education via WeChat (a new media) platform 6. Incentive-based campaigns	1. Chemotherapy 2. Common health education
Animal Health	1. Livestock screening and treatment 2. Drone monitoring for open grazing of livestock in the snail habitats 3. Wild rodent survey and deratization	1. Livestock screening and treatment
Environmental Health	1. Survey of wild feces and snails 2. Molluscicide 3. Water body surveillance 4. Environmental molecular biology surveys 5. Safe disposal of wild animal feces in snail habitats 6. Drone-based snail control 7. Plastic film mulching 8. Micro-environment modification for snail control	1. Survey of wild feces and snails 2. Molluscicide