Manzi et al. BMC Primary Care (2025) 26:329
https://doi.org/10.1186/s12875-025-03046-y

BMC Primary Care

RESEARCH Open Access

Optimizing community health workers and nonbiomedical approaches to assess the burden of soil-transmitted helminthiasis in a school-aged population in rural Rwanda

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Abstract

Background Soil-transmitted helminths (STHs) remain a public health problem for children in low- and middle-income countries. Conventional methods for STH diagnosis require well-equipped laboratories and trained personnel, which are often scarce or inaccessible in rural and resource-limited settings. Algorithmic non-biomedical screening tools are a potential strategy for community health workers (CHWs) to ensure rapid STH detection and referral of children. This exploratory feasibility study aimed at assessing whether a CHW-led, algorithm-based screening program could identify school-aged children with symptoms suggestive of STH and examining behavioral and environmental factors associated with a positive screening outcome in rural Rwanda.

Methods We conducted a cross-sectional feasibility study of 746 school-aged children in Musanze District, Rwanda, between August 2021 and November 2022. CHWs, trained as School-Based Health Agents, used the Beta CommScreen, an algorithmic nonbiomedical screening tool based on WHO-defined symptomatology and water, sanitation, and hygiene (WASH) indicators, to assess the risk of STH infection. CHWs engaged teachers and community members in developing a bundle of interventions, such as deworming campaigns, WASH education, and targeted home visits. Multivariate logistic regression (Stata 15.1) was used to identify factors associated with presumptive STH infection.

Results Among the 746 children screened, 322 (43%) reported symptoms consistent with possible STH infections, 220 (29%) were referred to the clinic for treatment, and the remaining children (102, 14%) were provided with deworming medication at school. Having a CHW for routine monitoring and not walking barefoot were associated with a lower risk of STH symptoms (OR = 0.36, 95% CI: 0.21, 0.64) and (OR = 0.49, 95% CI: 0.08, 3.11), respectively. While handwashing behaviors were significant in bivariate analyses, they did not retain statistical significance in the multivariate model. Other factors, including place of residence and age, were also not associated with STH symptoms.

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Conclusions The findings indicate that CHWs can effectively utilize a simplified algorithmic screening tool to identify children with symptoms suggestive of STH infections. This CHW-led model, when integrated within existing health and education systems, may enhance early detection and referral pathways. Further studies are needed to validate the screening tool, assess its diagnostic accuracy, and evaluate the cost-effectiveness and scalability of this approach.

Keywords Ascaris, Helminths, Hookworm, Neglected tropical diseases, Rwanda, School-aged children, School-based health agents, Soil-transmitted helminths, Whipworm

Background

Globally, 1.5 billion people, or 24% of the world's population, suffer from intestinal infections due to soil-transmitted helminths (STHs), which are considered neglected tropical diseases (NTDs) that disproportionately impact low- and middle-income countries (LMICs) [1]. Each year, more than 135,000 people die from these infections. Approximately 1.9 million years lived with disability are attributable to STHs [2]. The three most common parasitic worms include *Ascaris lumbricoides* (Ascaris), *Ancylostoma duodenale* (hookworm), *Necator americanus* (hookworm), and *Trichuris trichiura* (whipworm) [3]. The signs and symptoms of these parasitic infections vary from itching and localized rashes when the larvae penetrate the skin to abdominal pain, diarrhea, and weight loss [4].

In LMICs, parasitic worms are often responsible for acute and chronic malnutrition among school-aged children [5]. Their long-term impact includes developmental and cognitive impairment, resulting in poor school performance and overall quality of life [6]. Previous studies have demonstrated an association between STHs and malnutrition. In Rwanda, where 33% of children are stunted, STHs represent a significant health challenge [7]. *A. lumbricoides*, *T. trichiura*, and *A. duodenale* (hookworm) are the most prevalent STHs in the country [8].

While the epidemiological distribution of STHs in Rwanda varies, higher rates are often observed in rural areas where access to clean water and sanitation facilities is limited. The prevalence of STHs is exceptionally high at 40–60% in districts with poor socioeconomic status and inadequate hygiene practices [9, 10]. A previous nationwide survey reported that more than 50% of primary school children were infected with one or more species of intestinal worms. Ascaris and whipworm infection were found to be the most prevalent [11].

Barriers to STH detection among children in rural and remote regions

Biomedical approaches such as the Kato-Katz method, which uses microscopic fecal smears to identify eggs, remain the most commonly used tests for clinical diagnosis and assessment of the prevalence of STHs [8, 11]. All biomedical approaches require well-equipped laboratories and highly trained personnel. However, accessing this test requires visiting health centers that are often inaccessible in rural and remote settings or that present other access issues. Furthermore, several studies have reported the failure of the Kato-Katz method to detect hookworms, mainly due to the rapid degeneration of eggs, which increases the risk of reporting false negative results and hinders the timely initiation of treatment [12]. Khurana et al. described the most recent advances, including more sensitive molecular diagnostics, quantitative polymerase chain reaction (qPCR), and loop-mediated amplification assays, which maximize the level of precision in detecting STHs. However, such advanced techniques are unavailable or inaccessible in rural and remote communities [13].

While performing laboratory work via the Kato-Katz method or other sophisticated techniques remains the most recommended approach for diagnosing STHs, little is known about the feasibility of using signs and symptoms as a basis for routine screening of STHs in highly endemic and rural regions. The World Health Organization (WHO) has defined standard signs and symptoms associated with STH infections, including diarrhea and abdominal pain, malnutrition, impaired growth, and physical development [14].

Leveraging community health workers and an algorithmic approach for STH case detection

To enable school-based screening for potential STH infections among children, Move Up Global developed Beta ComScreen, a tablet-based CommCare application operated by community health workers (CHWs). The Beta ComScreen can be found in Supplementary Table S1. While teachers and other school-based personnel are often the first to identify preventable conditions among students and families, they are frequently limited by health workforce shortages or a lack of linkages between schools and local health facilities.

To address the need for healthcare workers to carry out screening, Move Up Global designed the Knot (Ipfundo) model, which equips CHWs to serve as liaisons between schools and local health facilities (Fig. 1). The Knot model is based on the principle that schools can serve as potential hubs for sparking change and improving community outcomes. Teacher and community engagement was implemented through the formation of a Community Advisory Council, which co-developed the intervention

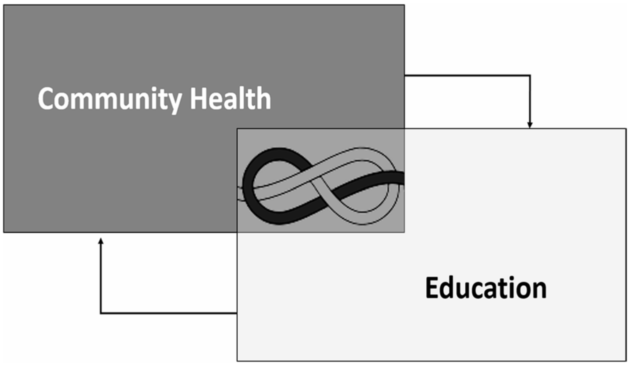

Fig. 1 Conceptual framework of the knot model connecting schools to community and primary healthcare systems

package and participated in feedback loops for refining health education and outreach activities.

The model illustrates how School-Based Health Agents (SBHAs) serve as a nexus between schools, health centers, and communities to enhance disease prevention and response efforts.

This exploratory feasibility study aimed at determining whether a CHW-led, algorithm-based screening approach could identify school-aged children presenting with symptoms suggestive of soil-transmitted helminthiasis (STH), and exploring behavioral and environmental determinants of a positive screening outcome in rural Rwanda.We also sought to describe the Knot model, which positions CHWs as school-based health agents (SBHAs) to strengthen school-community-health system linkages and support bundled preventive interventions through the active engagement of teachers, parents, and community members.

Methods

Study setting

This study was conducted at Nyabirehe Primary School, which is located in Musanze district, one of the five districts in the northern province of Rwanda. Musanze is the most populated district, with 476,522 residents in 2022. Approximately 57% of the resident population of Musanze is under 25 years old [15]. The population aged 17 and under represents 43% of the district's total population, 16–30 years represents 29%, and the working-age population 16 years and above represents 61.5% of the same population. The majority of the study population lives below the poverty line. The primary sources of income are agriculture and tourism, as the district is home to Volcanoes National Park and famous mountain gorillas [16].

Like other districts in Rwanda, Musanze's school system operates on a 6-3-3–4 system: six years of primary education, three years of lower secondary, three years of upper secondary, and four years of university for a bachelor's degree [17]. The official languages of instruction are Kinyarwanda in primary school (P1-P3) and English from the 4th year in primary school (P4) through university. In public primary and secondary schools, French and Swahili are offered as elective or supplementary subjects.

Nyabirehe Primary School is a public school that offers preschool through 9th-grade education. It is staffed by 25 teachers with high school certificates, known as the A2 level. The school has an enrollment of 1,229 students, approximately 6% of whom are in preschool. The school follows the national curriculum and uses English as the language of instruction from P4 onward.

Rwanda's school health profile

The government of Rwanda has developed a national school health policy and a strategic plan to promote the health and well-being of students and teachers in schools. The policy emphasizes the need for intersectoral collaboration among various ministries, agencies, partners, and stakeholders to ensure the effective implementation and monitoring of school health activities. The major components of Rwanda's school health programs include (1) health education, covering various topics such as hygiene, nutrition, HIV/AIDS prevention, sexual and reproductive health, and gender equality; (2) school health services such as periodic deworming and screening for malnutrition; (3) school feeding; (4) the physical environment of schools to make them safe, healthy and conducive for learning; and (5) ensuring that schools are free from violence, abuse, harassment, and discrimination [18].

Rwanda's school health strategy includes periodic mass drug administration (MDA) for STH infection, operationalized through local health centers and their clinical personnel, primarily nurses. The standard mechanism involves the Ministry of Health (MoH) distributing albendazole to district pharmacies, which in turn supply health centers responsible for conducting school outreach [19]. However, despite national initiatives to scale up the health workforce, significant shortages persist, particularly in rural areas where the nurse-to-population ratio remains critically low [20]. These constraints hinder the consistent delivery of preventive interventions, including school-based deworming programs, which are frequently delayed or deprioritized due to the competing demands of facility-based curative services. The insufficient and overburdened health workforce creates gaps in timely, routine access to school health services. The current national policy does not assign dedicated school-based health personnel, nor does it formally integrate CHWs into the school health system [19].

At Move Up Global-supported schools, SBHAs serve as an interface between local health centers and schools. In addition to screening students for STH infections, SBHAs implement a bundle of integrated interventions, including school-based deworming, WASH education sessions, the distribution of soap and hygiene-related educational materials, and follow-up household visits. SBHAs also provide basic first aid, psychosocial support, and ongoing health education to both students and their families.

The integration of CHWs into school health systems as SBHAs followed a structured process comprising the following steps:

- Select, orient, and deploy the CHWs as SBHAs, who systematically screen malnutrition, NTDs, and other conditions affecting education and overall health outcomes.
- The SBHAs serve as an interface between schools, health facilities, and communities. They facilitate referrals, counter referrals, and follow-ups for children with signs of STH infection.
- SBHAs ensure the proactive engagement of teachers and other community members in designing and validating bundled interventions to address STH infections, such as deworming campaigns, WASH education, and targeted home visits.
- SBHAs provide students with practical skills through simulations or real case reviews to build competencies to detect signs and risk factors for STH infections.
- SBHAs facilitate referrals to the nearest health facilities and collaborate with the existing public health system to prevent and treat NTDs, malnutrition, and other poverty-related conditions. The SBHA addresses common public health needs by providing teachers and students with the necessary skills, tools, and support to implement effective school health interventions. They also enhance the participation and engagement of students and parents in their own health and well-being through school-based health education sessions and home visits. SBHAs use hands-on skills-building approaches, including simulations and case scenarios.

Streamlining school-based screening and referral pathways

SBHAs screen students for NTDs and malnutrition using the Beta ComScreen at the schools. They also provide children with albendazole 400 mg twice a year to prevent STH infections. If the child is presumptively identified as having severe signs of STH infection, they are referred to the local primary care center for consideration for deworming medication (primarily albendazole), which is free. In addition, the SBHA coordinated with parents to arrange a visit to the local health post or center to have a complete check-up. The SBHA conducts a home visit a few weeks after the initial screening to ensure that treatment is received if the child is improving, and if anything else, the child or the family needs support to maintain the child's health. Furthermore, the SBHA checked whether community-wide MDA had occurred and liaised with the local health center to organize an MDA campaign. During routine screening, the SBHA confirmed that the children and their siblings had received deworming medications as recommended. CHWs were under the supervision of community health nurses at the nearest health center. The administration of albendazole was conducted in accordance with national guidelines issued by the Rwandan MoH. CHWs were trained to identify and report any adverse effects or unusual reactions following treatment, and referral protocols to certain health facilities were in place for the management of side effects or suspected treatment failure.

The SBHA also provides health education materials to describe the best prevention methods for NTDs (for example, water treatment interventions) and leaves informational packets at the household (Fig. 2).

The flowchart depicts identification, triage, deworming, referral, and home follow-up processes performed by SBHAs.

In addition to performing systematic screening and administering deworming medications, the SBHA provides hands-on health education and helps families improve hygiene and sanitation during their home visits. This includes using and cleaning toilets as well as the basics of water treatment, including water chlorination.

To avoid disruption of their routine activities as CHWs, SBHAs visit schools before and after carrying out their existing community-based health interventions. During holidays, SBHAs increase their home visits to follow up on children identified with signs of STHs and intensify community-based health education. A community advisory board, composed of representatives of parents, school administrations, and community members, determines the SBHA's stipend covered by the local implementation partner. The advisory committee also reviews and provides feedback on the SBHA's priorities.

Data collection

The school-based screening initiative was established programmatically as part of Move Up Global's Knot (Ipfundo) model to facilitate early identification and referral of children with symptoms suggestive of STH. For this study, we conducted a secondary analysis of these programmatic records. An existing CHW, with over five years of service in integrated community case management, was selected and trained as an SBHA to use the Beta CommScreen tool. All enrolled students were invited to visit the SBHA's office for routine

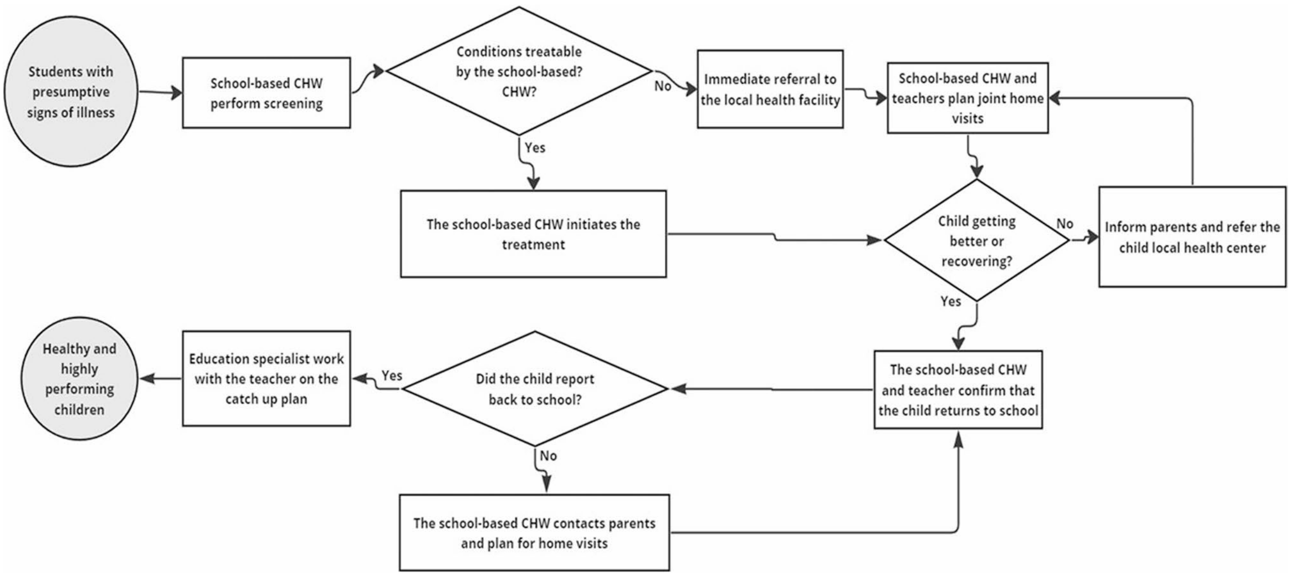

Fig. 2 Operational workflow for school-based screening and referral led by community health workers using the Beta Commscreen tool

screening. Data captured through the tablet-based CommCare application included sociodemographic characteristics, anthropometric measures (height and weight), self-reported symptoms within the preceding 72 h (e, g., abdominal pain, diarrhea, vomiting, fatigue, itching), and household- and WASH indicators (e.g., soap availability, toilet use, handwashing, footwear). Children were classified as presumptively positive if they presented with ≥5 concurrent symptoms consistent with STH. This threshold was informed by WHO guidelines and reflects the clinical features of STH infections, including diarrhea, abdominal pain, malnutrition, general malaise and weakness, and impaired growth and physical development. The selection of five or more concurrent symptoms aligns with syndromic screening models such as the Integrated Management of Childhood Illness and TB symptom checklists. Using a tablet-based version of the Beta ComScreen, the SBHA screened children for STH infections. With guidance from community health nurses, the SBHA administered albendazole tablets to children with at least five symptoms of STH infection. Children with STH symptoms lasting more than three days after taking albendazole were referred to the local health center for further investigations. All the children received health education and counseling from the SBHA.

A total of 746 students were screened between August 2021 and November 2022. The data were securely stored on the tablets and uploaded to a CommCare cloud server after each screening session.

Ethics approval and consent to participate

The Rwanda National Ethics Committee approved this study (No. 302/RNEC/2022). Screening activities were implemented programmatically as part of routine school health services, and the ethics approval authorized the secondary use of these data for research purposes. For the primary programmatic screening, written informed consent was obtained from parents or guardians and assent from students prior to participation. All research-related data extraction and analyses were conducted only after ethical approval was granted. To ensure confidentiality, datasets were fully de-identified, and all personal identifiers were removed prior to analysis.

Funding

This research received no external funding. However, the CommCare software license used to develop the Beta CommScreen tool was generously donated by Dimagi, Inc.

Data analysis

We analyzed the data using Stata version 15.1 (College Station, TX). We performed descriptive statistics to summarize the characteristics of the study population and the prevalence of presumptive STH infections. We performed bivariate analysis to examine the association between each independent variable and the outcome variable (STH, defined as self-reported STH symptoms). We used chi-square tests for categorical variables and t-tests for continuous variables.

Variables with a p-value less than 0.20 in bivariate analyses were considered for inclusion in the multivariate logistic regression model to identify independent predictors of presumptive STH infection. Multicollinearity among covariates was evaluated using Pearson's correlation coefficient ($r > 0.8$). In cases of high collinearity, the variable most strongly associated with the outcome was retained. Model refinement was conducted using a manual backward elimination procedure, with statistical significance set at $p < 0.05$. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test ($p = 0.21$), indicating satisfactory calibration between observed and predicted values. The pseudo-R^2 value (0.32) was used to assess the proportion of variance explained by the final model.

Table 1 Bivariate relationships between demographic characteristics and possible STH infection

Characteristics	N	%	OR	95%CI	P Value
Age group					0.860
< 7 years old	307	41	1.00		
8–14	372	50	1.08	[0.79,1.46]	
15–21	67	9	1.12	[0.66,1.90]	
Residence					0.671
Remote villages	28	4	1.00		
Local villages	718	96	1.18	[0.55,2.56]	
BMI					0.640
≤ 18.5	444	60	1.00		
> 18.5	301	40	0.93	[0.69,1.25]	
Walking barefoot*					< 0.001
No	66	8.85	1.00		
Yes	680	91.15	13.62	[4.90,37.85]	
Bar soap at home*					< 0.001
Yes	60	8.04	1.00		
No	686	91.96	25.36	[6.14,104.64]	
Handwashing before eating*					< 0.001
Yes	67	8.98	1.00		
No	679	91.02	28.96	[7.04,119.26]	
Handwashing after using toilet*					< 0.001
Yes	67	9	1.00		
No	679	91	28.97	[7.04,119.26]	
Recent sickness					0.457
No	417	56	1.00		
Yes	329	44	1.12	[0.83,1.50]	
Ascariasis*					< 0.001
No	520	70	1.00		
Yes	226	30	3.02	[2.19,4.18]	
Hookworm*					< 0.001
No	649	87	1.00		
Yes	97	13	2.28	[1.47,3.53]	
Whipworm*				0.003	
No	726	97.32	1.00		
Yes	20	2.68	4.09	[1.47,11.39]	
Referred to the clinic*					< 0.001
No	526	70.51	1.00		
Yes	220	29.49	3.81	[2.73,5.31]	
Under CHW monitoring*					< 0.001
No	338	45.31	1.00		
Yes	408	54.69	0.27	[0.20,0.36]	

* indicates statistical significance at $p < 0.05$.

Continuous variables were evaluated for outliers using visual inspection of histograms and boxplots. No extreme values warranted exclusion or transformation. Age and body mass index (BMI) were categorized based on public health cutoffs to enhance interpretability in programmatic settings.

Missing data were minimal (<5%) and assumed to be missing completely at random. Therefore, complete case analysis (listwise deletion) was applied in all statistical procedures. Potential confounding was addressed through multivariable adjustment; however, interaction terms were not explicitly tested.

Given the single-school design, clustering adjustments such as robust standard errors or multilevel modeling were not applied. We acknowledge the potential for intragroup correlation, which may have resulted in underestimated standard errors and an increased risk of Type I error. To address this limitation, future multisite studies will incorporate cluster-robust variance estimators or hierarchical logistic regression models to account for data dependency and improve precision in effect estimation. We reported the odds ratios (ORs), p-values, and 95% confidence intervals (CIs).

Results

Overall, 746 children participated in the study; 307 (41%) were under seven years old, 372 (50%) were between 8 and 14 years old, and 67 (9%) were over 15 years old (Table 1). Almost one-half (43%) reported symptoms consistent with possible STH infection on the basis of the algorithmic screening criteria. A total of 220 (29%) patients were referred to the clinic for treatment. The remaining children (102, 14%) were provided with deworming medication at school. Bivariate analysis revealed several factors associated with symptoms, including walking barefoot ($p<0.001$), not having soap at home ($p<0.001$), not washing their hands before eating ($p<0.001$), and not washing their hands after using the toilet ($p<0.001$). Other factors, including place of residence and age, were not associated with STH symptoms ($p=0.29$ and $p=0.38$, respectively).

In the multivariate analysis, most of the factors remained significantly associated with a positive screen on the app: Model fit was assessed using monitoring was associated with a lower risk of STH symptoms (OR = 0.36, 95% CI: 0.21, 0.64). Not washing hands before eating (OR = 7.40; 95% CI: 0.79–68.94) and after using the toilet (OR = 3.82; 95% CI: 0.37–39.37) tended to increase the odds of reporting symptoms consistent with possible STH infection. However, these associations were not statistically significant and were marked by wide confidence intervals, suggesting limited precision. Other factors, including place of residence and age, were also not associated with STH symptoms. (Table 2). Several associations,

Table 2 Multivariate logistic regression model with odds ratios, P values, and confidence intervals for children with possible STH infection

Characteristics	OR	*P* Value	95%CI
Age			
< 7 years old	1.00		
8–14	1.23	0.235	[0.87,1.75]
	1.37	0.303	[0.75,2.52]
Under CHW monitoring			
No	1.00		
Yes*	0.36	< 0.001	[0.21,0.64]
Walking barefoot			
No	1.00		
Yes	0.49	0.450	[0.08,3.11]
Bar soap at home	1.00		
Yes	1.00		
No	5.41	0.080	[0.82,35.72]
Handwashing before eating			
Yes	1.00		
No	7.40	0.079	[0.79,68.94]
Handwashing after using toilet			
Yes	1.00		
No	3.82	0.260	[0.37,39.37]
Ascariasis			
No	1.00		
Yes*	2.06	0.006	[1.24,3.43]
Hookworm	1.00		
No			
Yes*	2.47	0.001	[1.42, 4.29]
Whipworm			
No	1.00		
Yes	3.36	0.050	[1.00,11.29]
Referred to the clinic			
No	1.00		
Yes	1.02	0.933	[0.58,1.81]

[*] indicates statistical significance at $p < 0.05$.

particularly those related to hygiene behaviors, exhibited wide confidence intervals, likely due to low statistical precision from small subgroup sizes or sparse data. These findings should be interpreted with caution and regarded as exploratory. Given the study's exploratory design, we did not adjust for multiple comparisons, which increases the risk of Type I error. Therefore, statistically significant results, particularly those from bivariate analyses, should be viewed as hypothesis-generating rather than confirmatory.

Discussion

We found that CHWs could use a simple digital-based algorithm to screen school children for symptoms suggestive of STH. The findings of this study suggest the use of an algorithmic nonbiomedical screening tool as a practical approach for CHWs to carry out routine STH screening in highly endemic regions to identify children who need further assessment for treatment.

As such, instead of collecting stool samples and analyzing them in a lab, training CHWs and screening children at schools enabled an accessible option to identify children with signs of STH infection. Furthermore, CHW-led screening enhances community awareness of public health challenges and messaging. This approach also promotes ownership and community empowerment. Although biannual MDA campaigns are recommended, the health center's outreach to schools remains irregular. SBHAs liaise with local health centers to follow up on MDA implementation plans and provide support with school-based distribution.

To avoid disruption of their regular work as CHWs, SBHAs were asked to present at the school before or after completing the community-based assignments. This facilitated proactive identification of children with signs of STHs or children whose families needed particular attention.

As many countries explore strategies to improve universal health coverage, leveraging schools and CHW-led screening could accelerate the pace of eliminating STHs and other conditions that affect health and overall quality of life. For example, CHWs can have school rotations, be available to children needing screening and medications, and facilitate referral to a local health facility. This model can also build confidence between the local community and public health systems.

CHW training and the provision of standardized screening tools have been critical in ensuring high-quality and consistent screening. Prior relationships with the community and CHW experience enabled the implementation of this study, as the SBHA was a member of the community. Previous studies have reported Rwanda's success with CHW-led interventions to improve community case management of childhood illness [21, 22]. In developed countries, recent studies highlighted the role of CHWs in school-based interventions for children [23, 24].

Almost half of the study population had symptoms consistent with STH infection, which increased the need to visit the clinic, decreasing their time in class. The results of this study are consistent with those of previous studies that reported a high prevalence of STH infections [25, 26]. This places a burden on families and weighs on teachers, who must coordinate students' visits to the clinic. Donkoh et al. reported that children at schools were negatively impacted by STHs [27]. Our findings suggest the importance of better strategies for preventing and identifying infections with intestinal worms among school-aged populations.

This study's findings are consistent with those of other studies that reported high rates of STH infections in resource-limited settings [7, 11]. Our findings are similar to those of prior studies that assessed the geographical distributions of STH infections and their risk factors in Rwanda. For example, in a recent population survey in the northwestern regions of Rwanda, Ruberanziza et al. reported that *A. lumbricoides and T. trichiura* were the most prevalent STH parasites, at 37% and 23%, respectively [7]. Kabatende et al. reported that the prevalence of STH infections among school children was 77.7%. The most prevalent species were *T. trichiura* (66.8%), *A. lumbricoides* (49.9%), and hookworms (1.9%) [11].

Although poor handwashing practices were associated with higher odds of reporting symptoms in bivariate analysis, these associations were not statistically significant in multivariate models and should be interpreted as non-significant trends warranting further study. These patterns may reflect underlying environmental conditions, as most households in the study area have limited access to clean water. The communities surrounding Volcanoes National Park often rely on untreated sources such as rainwater, streams, or ponds. Inadequate handwashing, poor food hygiene, and limited access to safe water may contribute to increased exposure to STH infections in these settings.

Given the multifaceted contributions of social, economic, and demographic factors, STH elimination requires holistic consideration of health determinants, including innovations to break the cycle of poverty and disease, especially in rural and remote regions.

This study has a number of limitations. First, we relied on self-reported symptoms from children with no further diagnostic processes to determine possible infection on the basis of presenting symptoms. Although the screening tool was developed based on WHO-defined symptom profiles for STH [28], its sensitivity, specificity, and predictive values have not been validated against parasitological gold standards such as the Kato–Katz method or quantitative PCR. Consequently, the use of a symptom-based threshold (≥ 5 symptoms) to define presumptive STH may have led to both false positives and false negatives, potentially influencing referral accuracy and treatment decisions. Further studies are needed to determine the sensitivity and specificity of the algorithm across populations. We also acknowledge that relying on self-reported symptoms may have introduced recall bias, particularly among younger children. Moreover, the dual role of CHWs as both screeners and educators may have contributed to social desirability bias, whereby children provided responses they believed would please the CHWs. However, the use of a standardized digital tool, combined with CHW training to record rather than interpret responses, helped minimize interviewer-related variability. Furthermore, CHWs' longstanding relationships and trust within the community may have facilitated greater openness and symptom disclosure, partially mitigating the risk of biased responses. Finally, this study was conducted in a single school within one district, limiting the generalizability of the findings. Cultural, geographic, and infrastructural differences in other regions may affect both the feasibility and effectiveness of a CHW-led, school-based screening model. The lack of a comparison group or control group further limits our ability to attribute outcomes solely to this algorithm-driven screening approach. While this pilot study provides preliminary insights and demonstrates feasibility, it should be considered exploratory rather than confirmatory. Future research should prioritize rigorous validation studies and multi-site feasibility assessments to further strengthen the evidence base for CHW-led, school-based screening models.

Conclusion

This exploratory, school-based feasibility study demonstrated that CHWs can be equipped to screen for symptoms suggestive of STH infections via a simple, algorithmic tool in a resource-limited rural setting. However, given the absence of parasitological confirmation, the use of a non-validated symptom threshold, and the single-site design, these findings should be interpreted with caution. The results are not intended to quantify the epidemiological burden but rather to assess the operational feasibility of CHW-led screening models in school settings.

Despite these limitations, the integration of CHWs as SBHAs offers a promising strategy for bridging gaps between schools and the formal health system and may help identify and link at-risk children to care more efficiently in contexts with limited diagnostic infrastructure.

In resource-limited settings where human resources for health remain a pressing challenge, CHWs constitute a promising workforce to implement a school-based screening of childhood illnesses and eliminate STH infections and other life-threatening conditions. However, their success depends on practical and easy-to-use screening tools, training and mentorship, and a strong problem-solving system.

Community-defined and community-driven interventions are critical to accelerating the pace toward achieving Universal Health Coverage (UHC) targets. As per the Knot model, enhancing the linkage between schools and communities can expand the scope of work of CHWs and promote the prevention of STH infections and timely detection and referral of children with signs of STHs. SBHAs are well placed to carry out family-centered interventions for health education, surveillance, and disease prevention in a cost-effective manner, with potential for scalability. Further studies are underway to investigate the impact of implementing the Knot model and

SBHA-driven interventions on health, academic performance, and overall quality of life.

The engagement of teachers and community members was part of the intervention design and was supported by training, planning meetings, and participation in WASH education and follow-up activities. These activities were recorded through CHW reports. While we documented key SBHA activities and community engagement, these qualitative components were not systematically measured or evaluated as study outcomes. Future research should include formal process evaluations to assess implementation fidelity, community participation, and contextual barriers and facilitators.

Beyond research implications, the Knot model carries relevance for policy and program implementation. The model aligns with national priorities around task shifting, decentralization, and UHC and offers a cost-conscious approach that could be incorporated into national NTD programs and school health initiatives.

To inform broader adoption, future research should include a formal cost-effectiveness analysis, assess health and educational outcomes, and explore integration pathways with the national MoH and education. With appropriate validation and stakeholder engagement, the Knot model could serve as a replicable strategy across other endemic regions, meaningfully contributing to global NTD elimination goals.

Abbreviations

BMI	Body mass index
CHW	Community health worker
MDA	Mass drug administration
MoH	Ministry of Health
NTD	Neglected tropical disease
SBHA	School-based health agent
STH	Soil-transmitted helminth
WHO	World Health Organization
UHC	Universal health coverage

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12875-025-03046-y.

Supplementary Material 1

Acknowledgements

The successful completion of this study owes greatly to the unwavering commitment and efforts of the SBHAs at Move Up Global-Ireme. Special gratitude is extended to Dr. James Wolff and the students from Boston University for their invaluable contribution to the development of Beta CommScreen. Additionally, Anatole Manzi's work was supported by Dimagi Inc., for which we are thankful.

Authors' contributions

AM conceived the study. JN and ON collected the data. AM, BK, and DN participated in the data analysis and interpretation. AM, BK, EB, DN, JN, ON, and LH participated in the manuscript preparation. All authors read and approved the final manuscript.

Funding

This research received no external funding. However, the CommCare software license used to develop the Beta CommScreen tool was generously donated by Dimagi, Inc.

Data availability

The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 13 May 2024 / Accepted: 21 September 2025
Published online: 29 October 2025

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