Assessing the Knowledge, Attitudes, and Practices (KAP) towards deworming of community health workers and teachers, and the experiences and perspectives of local leaders in the national deworming program in Nyamagabe and Rutsiro Districts in Rwanda

By

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DECLARATION

We, Fernand Rwamwejo, Grace Iliza Ndatinya and Madalitso Ireen Mkata, hereby declare that the practicum capstone thesis has been written by us without any external unauthorized help, that it has been neither presented to any institution for evaluation nor previously published in its entirety or in parts. Any parts, words, or ideas, of the thesis, however limited, which are quoted from or based on other sources, have been acknowledged as such without exception.

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DEDICATION

It is with genuine gratitude that we dedicate this work to God Almighty for his unfailing love throughout the whole master's program journey. We also dedicate this dissertation to our families and friends in Rwanda, Malawi, USA, and Belgium who tirelessly supported and encouraged us since we embarked on this journey. Thank you for being our cheerleaders.

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ABSTRACT

Background: Worm infections are among the most prevalent neglected tropical diseases (NTDs) worldwide. In Rwanda, Schistosomiasis and Soil-Transmitted Helminths (STH) are the most common worm infections, mostly affecting school aged children. Since 2014, the government of Rwanda through the Ministry of Health (MOH), supported by World Health Organization (WHO) and World Food Program (WFP), adopted a nation-wide deworming program to address worm infections. This study was conducted to assess the KAP of Community Health Workers (CHWs) and teachers on deworming, and to explore the perspectives and experiences of local leaders who are primary implementers in this program.

Methods: This was a cross-sectional study consisting mainly of a quantitative survey with complementary in-depth interviews (IDIs). The study settings were Nyamagabe and Rutsiro districts in Rwanda. Cluster sampling was used to acquire CHWs and teachers for the survey, and purposive sampling was used to acquire local leaders for the IDIs. Quantitative data was analyzed using univariate, bivariate and multivariate techniques while qualitative data was analyzed thematically.

Results: A total of 852 CHWs and teachers completed the KAP survey on worm infections, among which 63.6% were female. A total of 54.1% of the respondents had a good knowledge score, estimated at ≥80%. The mean knowledge score was 78.04%. From the multivariate analysis, lack of training was shown to increase the odds of having poor knowledge (OR 0.487, 95% CI: 0.328 – 0.722, p <0.001). One attitude statement was associated with knowledge: "I am an important contributor to the prevention of Schistosomiasis in my community", as participants who had poor knowledge were less likely to agree with the statement (OR 0.215, 95% CI: 0.0079-0.580, p <0.001). With regards to practice, participants with good knowledge, were more likely to swim in rivers/lakes (OR 2.187, 95% CI: 1.242-3.850, p=0.006)

A total of 17 local leaders were interviewed. The 5 emerging themes were: (1) Community mobilization and sensitization by local leaders and CHWs improved the outreach of the deworming program, (2) Community members appeared to appreciate the decentralized deworming program and expressed the desire for expansion, (3) Complementary interventions to the deworming program, (4) Resistance and hesitance from caregivers were perceived as challenges to the deworming program, (5) Poor water access was identified as a drawback in the prevention of worm infections.

Conclusion: The findings from this study signify the importance of training CHWs and teachers on worm infections as they are the key personnel in the deworming program. Furthermore, the deworming program must be expanded to cover adults as they are also at risk of acquiring worm infections. There is a critical need to strengthen Water Sanitation and Hygiene (WASH) programs as complementary activities to deworming, which play a vital role in curbing worm infections. Intensified health education of community members on misconceptions towards deworming can help improve the outcome of the deworming program.

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ACRONYMS

CHWs: Community Health Workers
HGSF: Home-Grown School Feeding
IDIs: In-Depth Interviews
IRB: Institutional Review Board
KAP: Knowledge, Attitude and Practice
MDA: Mass Drug Administration
MOH: Ministry of Health
N: Number
NA: Not applicable
NTDs: Neglected Tropical Diseases
ODK: Open Data Kit
OR: Odds Ratio
PIs: Principal Investigators
RBC: Rwanda Biomedical Center
STH: Soil Transmitted Helminths
UGHE: University of Global Health Equity
UNICEF: United Nations Children's Emergency Funds
WASH: Water Sanitation and Hygiene
WFP: World Food Programme
WHO: World Health Organization

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1. INTRODUCTION

1.1. Background

Worldwide, worm infections affect over 2 billion people, the most common being STH and Schistosomiasis (Maddren et al., 2021). In Rwanda, the prevalence of these worm infections is up to 45% for STH, among school-aged children (RBC, 2021).

The government of Rwanda, through the Rwanda Biomedical Center (RBC) continues to develop initiatives towards the eradication of worm infections which affect the most vulnerable communities. One of these initiatives is the National Deworming program, which was recently decentralized at village level (RBC, 2021).

In 2016, WFP started its Home-Grown School Feeding (HGSF) programme in four of the most food insecure districts in Rwanda (Nyaruguru, Nyamagabe, Karongi, and Rutsiro), and has been supporting RBC in the national deworming program. This study was conducted in two of the four districts, namely Nyamagabe and Rutsiro.

CHWs have been helpful in the implementation of numerous health programs particularly in low and middle-income countries due to the trust they have built and their ability to engage with community members (WHO, 2017). In the national deworming program in Rwanda, CHWs collaborate with teachers and local leaders to perform Mass Drug Administration (MDA) as well as community sensitization and health education. This study, therefore, aimed to understand the KAP of CHWs and teachers on deworming, and the perspectives and experiences of local leaders in the decentralized national deworming program in Rwanda.

1.2. Problem statement

There is little information about the Knowledge, Attitude, and Practices (KAP) of CHWs and teachers on deworming, and the perspectives and experiences of local leaders in the national deworming program in Rwanda.

1.3. Objectives of the study

- To assess the knowledge, attitudes, and practices of CHWs and teachers on deworming by July 2021.
- To understand the perspectives and experiences of local leaders in the implementation of the national deworming program by July 2021.

1.4. Study rationale

To our knowledge, limited studies have been conducted in Rwanda to assess the KAP of CHWs and teachers on deworming, and the perspectives and experiences of local leaders in the national deworming program. Studies on worm infections in Rwanda have focused on prevalence and incidence of worm infections, as well as the effect of water and sanitation on worm infections

(Kabatende et.al., 2020; Mather, Hutchings, Budge, & Jeffrey 2020; Nyandwi et.al., 2017). A capstone study was done to assess the KAP related to STH in Rwandan villages (Sepe, 2009).

The gap in the literature concerning key implementers of the national deworming makes it difficult to develop context specific interventions to strengthen current interventions. This study hence might be helpful to inform key stakeholders involved in the implementation of the national deworming program and in the design of complementary interventions to address worm infections.

1.5. Organization of the report

The organization of this report is as follows:

1. **Introduction**- This first section introduces the study and assess the magnitude of worm infections and the need for this study in Rwanda. It also provides the study objectives.
2. **Literature Review**- This section gives an overview of the types of worm infections, their prevalence, and their impact. It also gives an overview of current interventions that are being implemented to address worm infections both in Rwanda and worldwide. The section ends by highlighting the gap in the literature and the rationale for conducting this research.
3. **Methods**- This section specifies the methodology and rationale for their use. It describes the settings where the study was conducted, the target population and sample size, some details on the data collection tool, the measures used, the data management and analysis process, as well as the ethical considerations of the study.
4. **Results**- This section covers both quantitative and qualitative study results. It includes the descriptive statistics of key demographics and measurables (KAP). It also presents significant associations between key measures. Finally, the five key themes that emerged from the in-depth interviews (IDIs) are highlighted in this section.
5. **Discussion**- This section discusses the major findings of the quantitative study as well as the results of the qualitative study, where major themes were explored in some depth. The findings were compared to previous studies that were conducted globally. The section explains the significance of the results of the KAP of the CHWs and the teachers, and the experiences and perspectives of local leaders in the decentralized national deworming program at village level. It also stresses the importance of implementing complementary WASH activities to the deworming program to curb worm infections, as well as the importance of the frequency of MDA according to WHO guidelines. This section ends by highlighting the limitations of the study.
6. **Conclusion and Recommendations**- This section briefly summarizes the study and the implications of its findings. It also offers recommendations on what could be done to improve the decentralized national deworming program in order to decrease the prevalence of worm infections in Rwanda. In addition, the section includes suggestions on future research that could strengthen the findings of this study and continue to inform future deworming interventions/ programs in Rwanda.

2. LITERATURE REVIEW

2.1. Overview of worm infections

Worm infections are among the most prevalent infections worldwide, affecting more than 2 billion people, the most common being STH and Schistosomiasis (Maddren et al., 2021). There are three major sub-species of STH: roundworms (*Ascaris Lumbricoides*), hookworms (*Ancylostoma Duodenale* and *Necator Americanus*), and whipworms (*Trichuris Trichiura*) (Tchuem Tchuenté, 2011). People infected with STH suffer from intestinal symptoms including diarrhea and abdominal pains, general malaise, and weakness (CDC, 2020). Schistosomiasis, also referred to as "Bilharzia", is caused by blood-dwelling flukes of the genus Schistosoma (WHO, 2020). The acute symptoms of Schistosomiasis include abdominal pain, fever, muscle ache, bloody stool, and urine, as well as painful urination (CDC, 2018). The recommended interventions to deal with STH and Schistosomiasis are mass deworming campaigns, and increased access to clean water, hygiene, and sanitation (WHO, 2020).

2.2. Transmission and risk factors of worm infections

Poverty is a risk factor for both STH and Schistosomiasis. Impoverished populations do not have adequate access to clean water and sanitation infrastructure in their homes and therefore use water from running water bodies to perform all hygiene activities such as washing their dishes, clothes or even bathing which exposes them to parasites. Moreover, the lack of sanitation infrastructure leads to open defecation which pollutes the environment and makes it a host for the parasites (WHO, 2020).

STHs are transmitted through eggs that are passed from the feces of an infected person. In places with poor sanitation, these eggs contaminate the soil. People then ingest roundworms or whipworms through consuming unwashed fruits or vegetables, or by eating with unwashed hands. Children might acquire them by playing in contaminated soils, putting their hands in their mouths or from infected water sources. Once ingested, eggs mature into adult worms in the intestine of the host, which in turn produce thousands of eggs daily (WHO, 2020). Hookworm eggs are not infectious through ingestion, but hatch when they are in soil into larvae that mature and can penetrate the human skin when they walk barefoot (CDC, 2020).

When it comes to Schistosomiasis, humans are infected when they come in contact with the larva forms of parasites in infected waters that subsequently penetrate their skin. In the body, larva mature within blood vessels, where they hatch eggs that can be released in urine or feces. Affected people then infect water when they urinate or defecate within freshwater sources. The eggs released from the excreta then hatch in the water, are swallowed by an intermediate host which is a snail, which then releases mature larva, and the cycle is complete when the larva reinfects a human exposed to the contaminated water by penetrating their skin (WHO, 2020).

People living in rural communities, where agriculture and fishing are commonly practiced, are at high risk of acquiring Schistosomiasis. Infested water bodies are a major source of transmission, where freshwater snails release Schistosoma parasites that infect anyone who gets in contact with the water. Adults who are engaged in fishing activities or doing laundry in these water bodies will

likely be infected. People living in these areas are even more at risk if they like swimming and playing in the lakes (WHO, 2020).

2.3. Prevalence of worm infections

According to the WHO, STHs affect 1.5 billion people worldwide constituting around 24% of the world population, of which 71% are in Asia, 16% in sub-Saharan Africa and 13% in Latin America and the Caribbean (Pullan et al., 2014). STHs most commonly affect children, with an estimated 267 million preschool-age children and over 568 million school-age children living in areas where it is actively transmitted (WHO, 2020).

Schistosomiasis affects 250 million people globally, coming from 78 different countries, of whom 85% are from sub-Saharan Africa (Sacolo, 2018). Moreover, among people infected with Schistosomiasis 123 million are children (Osakunor et al., 2018).

2.4. Long-term impact of worm infections

STHs can affect people from all age groups but have been associated with numerous long-term effects in children. Ascariasis and Trichuriasis are thought to decrease food intake, impair the digestive process, cause malabsorption, and frequently lead to a decreased growth rate (Crompton & Nesheim, 2002). Hookworms are associated with decreased iron levels and iron deficiency anemia (Crompton & Nesheim, 2002). Moreover, hookworms lead to decreased pregnancy outcomes, reduced childhood growth and diminished productivity (Crompton & Nesheim, 2002). Finally, cognitive impairment measured in terms of memory, learning, and intelligence has been observed in children affected by STHs (Pabalan et al., 2018).

Long-term Schistosomiasis infection is also associated with a wide range of chronic complications. When untreated, Schistosomiasis can take a chronic form and lead to various complications such as liver fibrosis or bladder cancer (CDC, 2018). Furthermore, Schistosomiasis was linked to other infectious diseases, such as its association with increased hepatitis C virus virulence in a study in Egypt, and urinary schistosomiasis found to be associated with HIV in a study in Zimbabwe (King, 2011).

2.5. Current interventions

WASH programs are important interventions that can help to curb the spread of worm infections. Such programs consist of the provision of safe water supply, ensuring the availability of sanitation infrastructure adequate for disposal of human excreta, and promotion of hygiene (Campbell et al., 2014). Implementation of WASH programs has proven to be efficient and effective in the reduction of STH and schistosomiasis exposure in the environment (Kosinski et al., 2012; Esrey et al., 1991). A systematic review of 144 studies on WASH revealed that the implementation of WASH facilities reduced the prevalence of STH by 29% and the prevalence of Schistosomiasis by 77% (Esrey et al., 1991).

Deworming, also referred to as preventive chemotherapy, is a technique that has been recommended by the WHO, with a target of treating at least 75% of all at-risk children in endemic

countries by 2020 and bringing the prevalence of heavy to moderate infections down to less than one percent (WHO, 2012). Deworming is usually conducted at a national level and consists of providing all children living in at-risk areas with anthelmintic drugs such as mebendazole and albendazole annually when the prevalence of any STH is 20% or higher. In areas where the prevalence of any STH is over 50%, the process should be done biannually. Among other advantages of deworming programs are their affordability and simplicity of use since medications do not necessitate medical professionals to be administered.

The focus of control programs to date has been on deworming, mainly targeting school children yet this approach alone poses issues of sustainability. This is because parents and other members of the community who have not received the intervention may put children at risk of re-infection. MDA with children who are thought to be more infected is considered to be a cost-effective way to control STH and schistosomiasis. Yet with worm infections predominant in areas of poor sanitation, a focus on deworming programs alone can prove insufficient since children can get re-exposed within communities. Calls have been made for these interventions to be combined with WASH programs for better control and elimination of intestinal worms (Campbell et al., 2014).

2.6. Worm infections in Rwanda

2.6.1. Prevalence in Rwanda

Schistosomiasis and STH are the most common NTDs in Rwanda (RBC, 2019). A nationwide study conducted by the Rwanda MOH in 2008 showed that 65.8% of 8,000 school-aged children had STH (Hookworms, Roundworms, and Whipworms), with a higher prevalence in rural districts compared to Kigali (MOH, 2010). A follow-up study conducted in 2014, showed a slight decrease in the prevalence, with an overall 45% of school-aged children infected with STH (Kabatende et. al., 2020).

A study conducted in 2019 revealed a nationwide prevalence of 22-38% of *Ascaris Lumbricoides* and *Trichuris Trichiura* and identified the Western and North-Western regions to have the highest burden. Based on these observations, estimates were made on the districts with the highest risk of infection (50%) and these areas include Nyamagabe district in the Southern province and Rutsiro in the Western province (Kabatende et. al., 2020).

In 2020, a study conducted in four districts along lake Kivu (Western province) showed that overall, 77% of schoolchildren were infected with STH (Kabatende et.al., 2020). Infection prevalence varied from one district to another, whereby Rubavu and Rusizi had the highest rates (92% and 89% respectively) compared to Nyamasheke (60%) and Rutsiro (54%) (Nyandwi et.al., 2017).

Some of Rwanda's lakes and rivers, such as Lake Ruhondo, Bulera, Kivu, Muhazi and Rweru, were identified as potential transmission areas of *Schistosomiasis Mansoni* (GAHI, 2021), which is the only Schistosoma endemic sub-species in the country (Stanford, 2016). Propagation of Schistosomiasis was associated with contaminated freshwater through urination or open defecation (GAHI, 2021). The 2008 mapping revealed a 2.7% nationwide prevalence of Schistosomiasis

(RBC, 2019), with a district level prevalence, ranging from 0 to 69.5% among school children (Nyandwi et. al., 2017).

2.6.2. Existing interventions

In 2014, the MOH set a target to reduce the intestinal worms' prevalence from 45% to 25% by 2024, through a multisectoral collaboration and decentralization of activities such as MDA to the local leadership at the village level (RBC, 2021). This included monthly malnutrition screenings and community sensitization programs (RBC, 2021).

In Rwanda, the main control intervention for treating parasitic worms in school-aged children has been MDA with Albendazole for STH and Praziquantel for Schistosomiasis (RBC, 2019). In 2007, the Rwandan MOH established the NTDs program, whose primary focus was among others the Schistosomiasis control initiative. Since 2008, under this initiative, biannual deworming tablets have been provided to children aged 1-15 years as well as once every year for Schistosomiasis (Ruberanzira, et al., 2020). Hygiene sensitization and improved sanitation programs and local capacity building through personnel training were also added to the MDA (Stanford, 2016). From 2007 to 2018, 42,000 CHWs were trained on the prevention of common NTDs. Thanks to these interventions, the 2014 re-mapping that surveyed school children showed a 30% decrease in prevalence (RBC, 2019).

The RBC conducts mass deworming campaigns biannually, where community sensitization and education on behavior change are made with the use of mass media and other communication tools (RBC, 2021). These have been largely supplemented by efforts from international organizations such as UNICEF (United Nations Children's Emergency Fund) through its WASH program that improves the population's access to safe water and sanitation and programs such as the sanitation and hygiene week to raise awareness on hygiene and sanitation.

2.7. Previous KAP studies

Knowledge, Attitudes, and Practices (KAP) regarding STH and Schistosomiasis are key elements that can guide the control and prevention strategies of these diseases. This is because they help to evaluate the effectiveness of sensitization programs, and social mobilization aimed at eliminating worm infections. Moreover, a good understanding of these aspects can help assess the gaps and provide guidance for future elimination programs.

Many studies have been conducted to assess the KAP in Africa and Asia where STH and Schistosomiasis are most prevalent. In Africa, KAP studies were conducted in Kenya, South-Africa, Nigeria, Ivory Coast, and Eritrea. Study participants included caregivers, teachers, local authorities, children, CHWs and a sample from the population ((Sacolo-Gwebu et al., 2019); (Ahmed et al., 2017); (Oyebamiji et al., 2018)). In Asia, one study was done in Malaysia looking at the KAP on STH among caregivers of school-aged children (Nasr et al., 2013). Another one in rural China looked at the KAP on worm infections among schoolchildren, parents, and community doctors (Lu et al., 2015).

Studies conducted in Africa revealed similarities with high awareness about STH, whereas differences existed in Schistosomiasis awareness. The study conducted in Ivory Coast revealed a high level of awareness about STH in the community with 67% of the participants acknowledging having heard about it, whereas that number was relatively low for schistosomiasis at 43% (Acka et al., 2010). As a comparison, the study done in South Africa revealed awareness of 78% about Schistosomiasis among study participants whereas 79% of the participants knew about STH (Sacolo-Gwebu et al., 2019). In Nigeria, 62% of the participants knew about STH (Oyebamiji et al., 2018). Among study participants of the study done in Eritrea, 72% reported previously having heard of intestinal worms (Ahmed et al., 2017).

Among people who reported knowing about STH and Schistosomiasis in these African studies, knowledge was found to decrease upon further questioning. With regards to knowledge about transmission in Ivory Coast, very few people were aware that STH could be transmitted from soils (Acka et al., 2010). In South Africa, among those who knew about STH, 62% of them knew how it is transmitted, 50% knew at least one sign and symptom, and only 42% knew about prevention measures (Sacolo-Gwebu et al., 2019). In Nigeria, among people who said they knew about STH, 88% did not know how it is transmitted or how to prevent it. In children surveyed in Eritrea who reported knowledge of STH, 76% had poor knowledge of how it is transmitted (Ahmed et al., 2017).

The source of information on worm infections was associated with the level knowledge of participants in previous studies: the study in Eritrea revealed that good knowledge about STH was acquired from school, whereas study participants who had not heard about it from schools had only a 3% awareness of the worms (Ahmed et al., 2017). In Ivory Coast, the source of information was mainly from two sources: the community and schools. In the community, control and prevention interventions that were implemented at the community level served as a source of information for the participants who had acquired their knowledge from community interventions and thus, had better knowledge than those who had acquired the knowledge from schools (Acka et al., 2010). In South Africa, the most reported source of information was from family and relatives as well as from community meetings, with the caregivers with the most correct responses having acquired it from community meetings (Sacolo-Gwebu et al., 2019).

Perception about worms among respondents was different across studies even though many considered STH and schistosomiasis to be dangerous. In Cote d'Ivoire, most participants perceived STH as dangerous, but they also held that both traditional and modern medicine could cure it (Acka et al., 2010). In South Africa, a misconception exists about schistosomiasis, where most participants confused it with Sexually Transmitted Diseases (Sacolo-Gwebu et al., 2019). Additionally, most males in the study in South Africa underestimated the seriousness of both STH and Schistosomiasis, considering them as infections that cannot cause death easily (Sacolo-Gwebu et al., 2019). Such misconceptions from various cultural understanding and myths can hinder the progress of control strategies in the case of STH and Schistosomiasis.

When it comes to practices regarding worms, 84% of the participants in Ivory Coast said to have taken anthelmintics drugs, 49% being traditional medicines (Acka et al., 2010). Moreover, most participants in Ivory Coast used surface drinking from unprotected water sources (Acka et al., 2010). Similarly, the study in Nigeria showed that the common source of drinking water was from open water sources. In Eritrea and South Africa, one of the poor practices was not washing hands

after defecation, present in 92% of the participants, with also a high prevalence of open defecation (Ahmed et al., 2017).

In Malaysia, there was a moderate awareness of people regarding STH, with 61% of participants having heard about it, while the knowledge on its transmission was low at 28% (Nasr et al., 2013). Among those who knew STH, 20% mentioned the clinic as a source of information, while more than 60% did not remember the source of information (Nasr et al., 2013). Moreover, only 29% of participants who knew were able to mention at least one symptom of STH and 28% knew about transmission routes. Additionally, among those who knew, 53% considered the STH to be harmful (Nasr et al., 2013). A handful of poor practices such as not washing hands before meals or after defecation, or walking barefoot, were mentioned by 30-50% of participants (Nasr et al., 2013). Treatment seeking behaviors was high, with 99% of people saying they seek treatment at clinics when sick (Nasr et al., 2013).

In a KAP study in rural China, three potential reasons were identified for the high prevalence of STH (Lu et al., 2015). The first reason was the low awareness among caregivers of school children who were both skeptical and unaware of the high prevalence of worms among children. The second reason was the local myths about worms, whereby in many villages people considered worms to be good for digestion, which prevented them from seeking deworming treatment. Deworming medicines were also thought to hurt fertility, leading to further reluctance to take deworming medicines. The final reason was the poor quality of healthcare in villages, which was attributable to the lack of village doctors in half of the villages where the study was conducted. Additionally, those who were available had inadequate knowledge about signs and symptoms of worms, the prevalence in the community and the correct dosage of deworming in children, whereby they gave half of the recommended dose by the WHO (Lu et al., 2015).

When it comes to CHWs, their perspectives and experiences about deworming programs are an important aspect in helping to design strong and sustainable programs for the elimination of STH and schistosomiasis. In Kenya, CHWs who had participated in mass drug administration of deworming medicines were interviewed about their perception and experiences (Omedo et al., 2012). CHWs with a high level of previous work experience reported a higher level of compliance in MDA than those with lower experience. Refusal to take drugs by members of the community was due to numerous factors such as conspiracy theories about the “real purpose of treatment”, perceived side effects experienced by some members of the community, as well as the relation between CHWs distributing drugs and members of the community. Even though the importance of female CHWs to provide equity, access and trust of healthcare services was stressed in the study, some specific challenges for women were found such as physical or verbal abuse from spouses as the distribution program was interfering with their domestic chores (Omedo et al., 2012).

2.8. Study gap

With a high number of STH and Schistosomiasis infections occurring in children, it is paramount to understand the KAP of teachers and CHWs, as it will help to ensure adequate training, support, and supervision of these key implementers of the deworming program (Melo E Lima et. al., 2018). In Rwanda, the national deworming program consists of MDA and education about worm infections to children and the community. These activities are conducted by health centers through outreach campaigns, where CHWs play a central role in the communities, and are assisted by

teachers in the schools. Moreover, local leaders are also important stakeholders as they supervise this program's implementation and provide local solutions for these communities to eradicate worm infections. Therefore, it is also important to understand their experiences and perspectives about the deworming program. Nonetheless, to our knowledge, there are limited studies in Rwanda to assess the KAP of teachers and CHWs on deworming, as well as experiences and perspectives of local leaders in the deworming program. This study sought to address this gap and provide insight into the Rwanda national deworming program.

3. METHODS

3.1. Setting

This study was conducted in partnership with WFP, Rwanda country office. WFP is the world leading humanitarian organization that provides food assistance in emergencies and works with communities to improve nutrition and resilience in more than 80 countries worldwide (WFP, 2021). WFP has been implementing the HGSF programme since 2016 in four of Rwanda's most food insecure districts: Nyaruguru and Nyamagabe in the Southern province, as well as Karongi and Rutsiro in the Western province. The program implements numerous complementary activities aiming to improve students' quality of education, academic performance, and health. This includes supporting deworming activities in schools as part of the biannual integrated health week, in partnership with the RBC. WFP's support goes towards funding, logistics and trainings associated with the campaigns, while deworming tablets are provided by the WHO (WFP, 2019).

This study took place in Nyamagabe and Rutsiro districts. These two districts were selected from the program's four districts as they were found to be at a higher risk for STH and Schistosomiasis (Kabatende et.al., 2020). While deworming is conducted nationwide, the HGSF programme is implemented in 25 schools in Nyamagabe district and 21 schools in Rutsiro district.

Nyamagabe is subdivided into 17 administrative sectors, 92 cells and 586 villages ("GoR Nyamagabe", 2019). The total population in Nyamagabe is 330,000 and there was a total of 1,608 CHWs, and 395 teachers within the HGSF programme. Rutsiro is made up of 13 administrative sectors, subdivided into 62 cells and 483 villages. The total population in Rutsiro is 324,654 with a total of 1,449 CHWs, and 360 teachers within the HGSF programme. (Rutsiro, 2021).

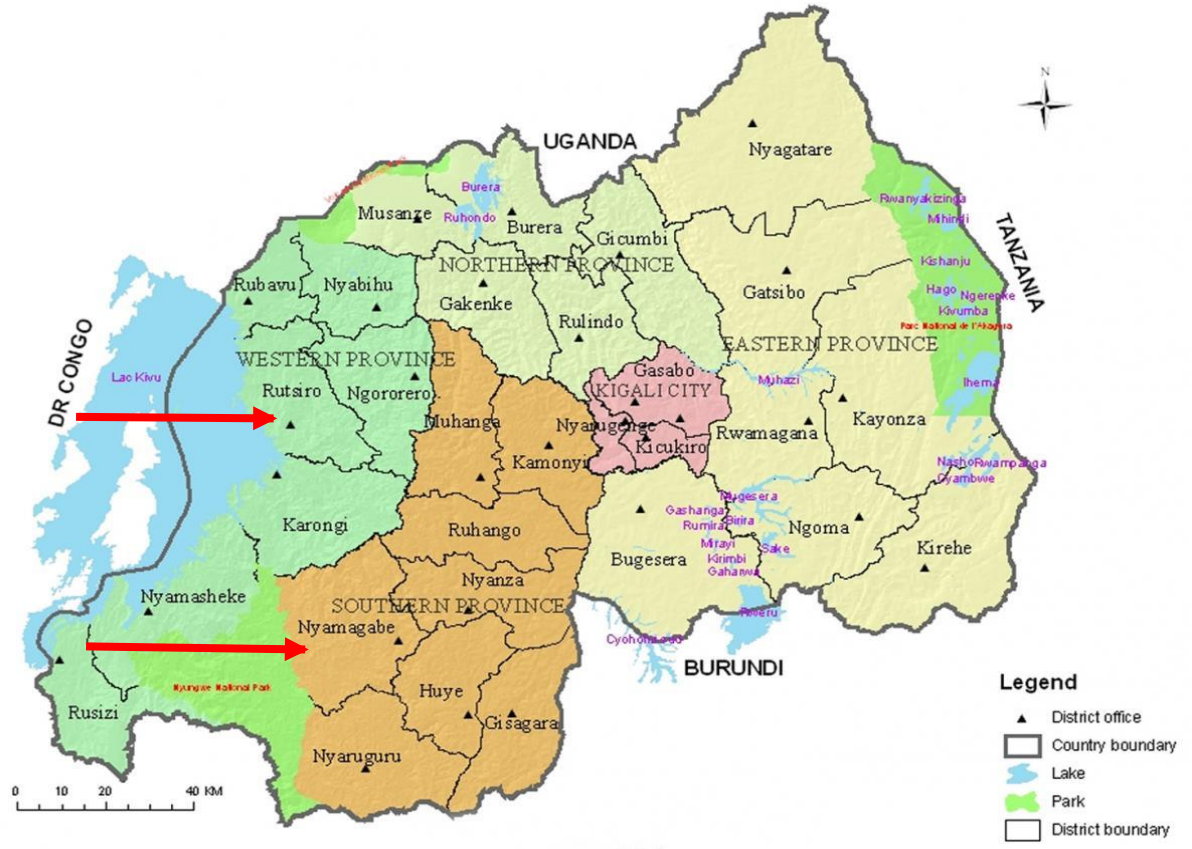

Figure 1. Map illustrating study locations (Rwanda map with Districts, 2021)

3.2. Design

This study consisted of a quantitative survey with complementary IDIs. The quantitative component was a cross sectional study that collected information about the KAP of teachers and CHWs on deworming and the qualitative component was a phenomenological design that assessed the experiences and perspectives of local leaders (village leaders) about the deworming program being implemented at the community level.

3.3. Sample

Quantitative Sampling:

The target population for the survey was teachers and CHWs from the selected schools and villages in both districts.

Inclusion criteria:

- Teachers and CHWs working in schools/ villages where the HGSF is implemented in Rutsiro or Nyamagabe districts.

Exclusion criteria:

- Teachers and CHWs who did not participate in the national deworming program.

Teachers:

Sample size: The total number of teachers in Rutsiro and Nyamagabe was 755 from 46 schools. From this number, a total sample size of 343 teachers was calculated basing on the following formula, using 95% confidence interval and 0.05 margin of error:

$$\mathbf{n} = \left[t^2 \times \frac{p \times q}{d^2}\right] \times DEFF$$

$$\mathrm{n} = \frac{n_0 N}{n_0 + (N - 1)}$$

$$\text{Final N} = \frac{\text{Number of teachers needed}}{\text{1- NRR}}$$

Teachers:

Parameter	Value
Total sample (N) in the 2 districts	755
t = linked to 95% confidence interval for cluster sampling	1.96
p = expected prevalence (fraction 1)	0.5
q = 1-p (expected non-prevalence)	0.5
d = relative desired precision	0.05
DEFF = design effect	1.5
n = sample size	$[(1.96)^2 *((0.5* (1-0.5))/ (0.05)^2)] * 1.5= 576$ (755*3057)/ (576+(754-1)) = **326**

Non-response rate	5%
Final N= Sample Size	326/ (1-0.05) =**343**

Teachers:

District	Number of teachers	Sample needed	Average number of teachers/ schools	Number of schools to cluster sample
Nyamagabe	395 (52.3%)	52.3% x 343 = 180	14	180/14 = 13
Rutsiro	360 (47.7%)	47.7% x 343 = 163	13	163/13 = 12
Total	755	343		

Sampling method:

Cluster random sampling method was used to acquire the sample. The proportion of teachers per district was 52.3 % in Nyamagabe and 47.7% in Rutsiro (395 in Nyamagabe and 360 in Rutsiro). To achieve the sample of 343, 180 teachers from Nyamagabe and 163 from Rutsiro were targeted. There were 14 teachers per school on average in Nyamagabe district and 13 teachers per school on average in Rutsiro. Therefore, 13 schools from Nyamagabe district and 12 schools from Rutsiro district were randomly selected, using a random sampling software, from a list of all 21 schools in Rutsiro and 25 schools in Nyamagabe. All teachers who fulfilled the selection criteria in the 25 selected schools were surveyed.

CHWs:

Sample size

The total number of CHWs in Rutsiro and Nyamagabe was 3,057 from 154 cells. From this number, a total sample size of 509 CHWs was calculated, based on the following formula using a 95% confidence interval and 0.05 margin of error:

$$\mathbf{n} = \left[t^2 \times \frac{p \times q}{d^2}\right] \times DEFF$$

$$\mathbf{n} = \frac{n_0 N}{n_0 + (N - 1)}$$

$$\text{Final N} = \frac{\text{Number of CHWs needed}}{\text{1- NRR}}$$

CHWs:

Parameter	Value
Total sample (N) in the 2 districts	3057
t = linked to 95% confidence interval for cluster sampling	1.96
p = expected prevalence (fraction 1)	0.5
q = 1-p (expected non-prevalence)	0.5
d = relative desired precision	0.05
DEFF = design effect	1.5
n = sample size	$[(1.96)^2 *((0.5* (1-0.5))/ (0.05)^2)] * 1.5= 576$ (576*3057)/ (576+(3057-1)) = **484**
Non-response rate	5%
Final N= sample size	484/ (1-0.05) = **509**

CHWs:

District	Number of CHWs	Sample needed	Average number of CHWs/Cell	Number of cells to cluster sample
Nyamagabe	1608 (52.6%)	52.6% x 509=268	18	268/18=15

Rutsiro	1449 (47.4%)	47.4% x 509=241	24	241/24= 10
Total	3057	509		

Cluster random sampling method was used to acquire the sample. The proportion of CHWs per district was 52.6 % in Nyamagabe and 47.4 % in Rutsiro (1608 in Nyamagabe and 1449 in Rutsiro). To achieve the sample of 509, 268 CHWs from Nyamagabe and 241 from Rutsiro were targeted. There were 18 CHWs per cell on average in Nyamagabe district and 24 CHWs per cell on average in Rutsiro. Therefore, 15 cells from Nyamagabe district and 10 cells from Rutsiro district were randomly selected, using a random sampling software, from a list of all 92 cells in Nyamagabe and 62 cells in Rutsiro. All CHWs who fulfilled the selection criteria in the 25 selected cells were surveyed.

Qualitative sampling:

Purposive sampling was used to select local leaders from communities in Rutsiro and Nyamagabe districts.

Local leaders selected were village leaders who were part of the administrative structure of Rwanda. Sampling continued until theoretical saturation was reached (the point at which no new information was arising from the participants).

Inclusion criteria

- Local leaders in Rutsiro or Nyamagabe districts who participated in the national deworming program.

Exclusion criteria

There were no exclusion criteria for local leaders who fulfilled the inclusion criteria.

Contact details of local leaders were acquired from health district coordinators, they were contacted through phone calls and an appointment was made with those agreeing to participate in the study.

3.4. Data collection procedures

Quantitative data collection

Approvals to conduct the survey with the teachers were obtained from the directors of the selected schools. Researchers went to the schools at the pre-agreed appointment date to collect data.

CHWs were contacted through phone calls according to the contact information provided by health district coordinators. Appointments were made with those who agreed to participate in the study. Data collectors met the CHWs at their preferred locations according to the appointment.

After detailed explanation of the study was provided to them, all teachers and CHWs provided signed informed consents.

Data was collected using anonymous structured questionnaires programmed with Open Data Kit (ODK) application and ONA platform on Samsung Galaxy 3 Pro v8.5 tablets. The data collectors read and recorded the responses from the study participants. The survey took approximately 10-20 minutes per participant to be completed. The collected data was reviewed each day to ensure quality and completeness during data collection. Review sessions were held every two days with the WFP enumerators to provide feedback.

Qualitative data collection

Local leaders who fulfilled the selection criteria were contacted through phone. Researchers met with them at agreed appointment time and locations. Informed consents were collected before the interviews. Permission to record the conversation using digital recorder and taking interview notes were also obtained. Interviews were conducted in a private environment, for example, at their home or in their office, to ensure participants' privacy.

3.5. Data collection tools

A survey questionnaire with 33 multiple choice questions was used to assess the KAP of teachers and CHWs on worm infections as well as the deworming program (appendix 2). The content of the survey was adapted from a KAP research on Schistosomiasis conducted on residents and CHWs in Northern Samar, Philippines (Inobaya et al., 2018). The survey questionnaire was developed in English then translated to Kinyarwanda by the principal investigators (PIs) who are fluent in both languages. To validate the translation, the questionnaire was translated back to English by another translator who was blinded to the original questionnaire. The survey was conducted in Kinyarwanda.

The in-depth interview guide contained open questions to understand the experiences, challenges as well as best practices or recommendations from local leaders on the national deworming program in Nyamagabe and Rutsiro (appendix 2). Qualitative questions were developed in English then translated to Kinyarwanda by the PIs. To validate the translation, the questionnaire was translated back to English by another translator who was blinded to the original questionnaire. Interviews were also conducted in Kinyarwanda.

Prior to data collection, the tools were pretested on five teachers and five students from the University of Global Health Equity (UGHE). Piloting was conducted with three CHWs, three teachers and two local leaders from Nyamagabe and Rutsiro.

3.6. Data collectors

Six WFP enumerators who had previous training in research and were fluent in reading and speaking Kinyarwanda were involved in conducting the survey. The enumerators were provided a one-day training on how to conduct the survey by the PIs prior to data collection.

The in-depth interviews were conducted by the PIs, who were Kinyarwanda speaking members of the research team.

3.7. Measures

The study had four key measures:

1. Knowledge score: Knowledge score was first calculated as a percentage of correct answers on the knowledge questions. The knowledge score was categorized as "Good" if knowledge score was 80% and above, and "poor" if knowledge score was below 80% (Bloom, 1956).
2. Attitude category: Each attitude statement was measured on a four-point Likert scale for those who "strongly agree, agree, disagree, and strongly disagree". For each statement of attitudes, "strongly agree" and "agree" were categorized into one group, while "disagree" and "strongly disagree" were categorized into another group. The percentages of "agree/strongly agree" and "disagree/strongly disagree" were used for analysis.
3. Practice category: The practice category was also measured on a four-point Likert scale for "never, rarely, often, and always". For practice questions, "often" and "always" were grouped into one category and "rarely" and "never were grouped into another category. The percentages of "often/always" and "never/rarely" were used for analysis
4. The experiences and perspectives of local leaders on the national deworming program: This was done by assessing the challenges or opportunities they experienced in the implementation of the deworming program, the best practices that they have supported at local level, as well as their recommendations on potential areas of improvement in the program.

3.8 Data management

Anonymized quantitative data was collected via electronic survey forms with the ODK application. This data was then exported to Microsoft Excel and cleaned. Subsequently, the data was imported to SPSS version 27.0.1 for analysis.

Qualitative data was uploaded to computer and then deleted from the recorders. The digital recordings were transcribed, then translated from Kinyarwanda to English. Data was then imported into Dedoose software for analysis.

All digital data were stored on UGHE password protected computers for security purposes, in accordance with Institutional Review Board (IRB) regulations. Hard copies of consent forms and field notes were stored in a locked cabinet.

All data will be destroyed after 10 years upon completion of the study, according to UGHE IRB regulations.

3.9 Data analysis

Descriptive statistics were used to summarize all demographic characteristics, and KAP levels of participants.

Chi-square tests were used to analyze the association between knowledge level and demographics, between knowledge level and attitude category, and between knowledge level and practice category.

All demographic variables with P<0.10 in the bivariate analysis were then included in the logistic regression for further analyses.

All the statistical tests were performed using SPSS version 27.0.1, with a p-value set at 0.05 for multivariate analysis.

Thematic analysis was conducted for the in-depth interviews data. After transcribing and translating the data to English, transcripts were divided and read in depth by each team member to identify emerging concepts. Then, the team discussed the concepts and developed the preliminary codebook based on the interview responses. The preliminary codebook was applied to 6 transcripts by the researchers separately. Subsequently, the research team consolidated the final codebook. All transcripts were coded based on the final codebook inductively and iteratively. Coding was conducted using Dedoose software. Themes that rose from the data were identified and explored by the team members, first individually then together as a team. Subsequently, quantitative, and qualitative findings were presented together.

3.10 Ethical protection plans

This study was approved by the UGHE IRB, with approval number: #135.

Vulnerable populations

The study did not involve any vulnerable population.

Assessment of risks to participants

CHWs and teachers could have felt uncomfortable as though their capacity as educators would be tested by the survey. They could have feared that their score on the survey would be disclosed and discredit them as educators at the community and school level respectively. To address this, no names and telephone numbers were collected from them. This means that no one could be able to attribute survey scores to respondents.

Local leaders may have hesitated to share their honest opinions about the national deworming program, thinking their responses may question their adherence to the program if shared outside the research settings. To mitigate this, anonymity was preserved, where no respondent was required to share any identifiable information such as names and they were assured that their responses could not be traced back to them. In addition, all participants were informed that they could withdraw from the study at any time without facing any consequences/ penalties.

Medical or psychosocial support

There was no likelihood of participants to suffer from medical or psychosocial harm/trauma in relation to participating in the study.

Information and consent process*:*

The purpose of the study was explained to the participants prior to signing the informed consent. The participants were informed that they had the right to voluntarily participate in the research

study, the right to review the research material and to withdraw at any point in the study process without facing any penalties. The identity of the researchers was disclosed and the person whom to contact if they encountered any problems within the research process was given to the participants. Any anticipated risks that the participants could encounter by participating in the research were clarified.

The consent form was provided in the participant's language (Kinyarwanda) for easy communication, and it was also indicated that participants would not receive any incentives in any way including monetary or otherwise, from taking part in the study. Data collection was only commenced once consent forms were signed.

Protection of privacy and confidentiality

Quantitative data: The data was collected via in-person interviews and no names were collected. Participants were given a unique identifier, and birthdates as well as addresses were stored separately from the data collected so that it cannot be linked to the respondent's information. The PIs had the exclusive ability to connect both data sets. Additionally, data collected was stored in a password protected computer and in an encrypted document.

Qualitative data: No identifiable data such as names, telephone numbers and addresses were collected.

De-identification of data

The study used unique numeric identifiers to label participants data instead of using their names or other identifiers.

Safekeeping of data

The study used strong encryption when storing the data on computers and laptops. The university's network storage was also used with access limited to the researchers and the supervisors. The data will be kept and then destroyed after 10 years as per UGHE IRB requirements.

COVID-19 measures

COVID-19 measures were respected throughout the data collection period. Data collectors were trained to abide by the COVID-19 measures while collecting data. These included social distancing (to leave 1 meter between them and the study participants), wearing a mask properly, and frequent hand washing or use of hand sanitizers. The PIs also observed these COVID-19 measures when interacting with study participants.

Conflict of interest

The national deworming program is implemented by RBC, while WFP provides support to the program. The research was intended to know how best WFP could improve this support in the future. Therefore, any area of improvement revealed by this research presented an opportunity for WFP to make better informed decisions towards the program, rather than a conflict of interest. In

addition, UGHE conducted this research as an independent party and was neutral to the findings. Neither RBC nor WFP intervened during data analysis.

4. RESULTS

4.1. Quantitative results

4.1.1. Sample demographic characteristics

A total of 852 people were surveyed, among which 509 (59.7%) were CHWs and 343 (40.3%) were teachers. Out of the 852 respondents, 542 (63.6%) were female, 382 (44.8%) had received training on deworming, 448 (52.6%) were from Nyamagabe and 404 (47.6%) from Rutsiro. Among the 382 participants who had received training, 370 were CHWs and 12 were teachers.

The mean age was 41.31, ranging from 20 to 70 years old. The participants had an average of 10.13 years of work experience. Among all the respondents, 400 (46.9%) had primary education, 401 (47.1%) had secondary education, 28 (3.3%) had university education, 22 (2.6%) had vocational training only and 1 participant (0.1%) had literacy classes only. Among CHWs, 399 (78%) had primary education, and 87 (17%) had secondary education. Among teachers, 314 (91.5%) had secondary education and 27 (7.9%) had university education (Table 1)

Table 1. Social demographic characteristics of the participants on deworming.

Characteristics	Variables	CHWs	Teachers	N (%)
Sample		509 (59.7)	343 (40.3)	852
Age	18 – 35	84 (16.5)	173 (50)	257 (30.2)
	36- 49	279 (54.8)	140 (40.8)	419 (49.1)
	≥50	146 (28.7)	30 (8.7)	176 (20.7)
	Mean (SD)	44.7 (9.1)	36.2 (9.9)	41.31 (10.303)
	Range	24 – 70	20 – 65	20 – 70
Gender	Male	173 (34)	137 (39.9)	310 (36.4)
	Female	336 (66)	206 (60)	542 (63.6)
District	Nyamagabe	268 (52.7)	180 (52.5)	448 (52.6)
	Rutsiro	241 (47.3)	163 (47.5)	404 (47.4)
Marital status	Single	4 (0.8)	73 (21.3)	77 (9.0)
	Married	479 (94)	267 (77.8)	746 (87.6)
	Divorced	10 (2)	1 (0.3)	11 (1.3)
	Widowed	16 (3.1)	2 (0.6)	18 (2.1)
Education level	Primary	399 (78)	1 (0.3)	400 (46.9)
	Secondary	87 (17)	314 (91.5)	401 (47.1)
	University	1 (0.2)	27 (7.9)	28 (3.3)
	Vocational training only	21 (4.1)	1 (0.3)	22 (2.6)
	Literacy classes only	1 (0.2)	0	1 (0.1)
Years of experience	≤ 5	171 (33.6)	121 (35.3)	292 (34.3)
	≥ 6	338 (66.4)	222 (64.7)	560 (65.7)
	Mean (SD)	9.61 (6.3)	10.9 (9.2)	10.13 (7.629)
	Range	0 – 35	0 – 44	0 – 44
Training				

	Trained	370 (72.7)	12 (3.5)	382 (44.8)
	Not trained	139 (27.3)	331 (96.5)	470 (55.2)
Year when they received training on worm infections	2016	26 (5.1)	3 (25)	29 (7.6)
	2017	12 (3.2)	1 (8.3)	13 (3.4)
	2018	30 (8.1)	1 (8.3)	31 (8.1)
	2019	77 (20.8)	3 (25)	80 (21)
	2020	143 (38.6)	3 (25)	146 (38.2)
	2021	82 (22.2)	1 (8.3)	83 (21.7)

4.1.2.Assessment of knowledge

The overall mean knowledge score on STH and Schistosomiasis was 78%. A total of 461 (54.1%) participants had a good knowledge level (score ≥80%). The overall mean knowledge score on STH was 82.6%, and 74.5% on Schistosomiasis. The mean knowledge score on STH and Schistosomiasis was 78.6 % for CHWs and 77.2% for teachers.

The three knowledge questions for which the highest percentages of respondents answered correctly were 1) "Swimming in contaminated water can lead to schistosomiasis" (95.1%), 2) "you can acquire STH from walking bare foot" (94.4%), and 3) "You can transmit Schistosomiasis from open defecation" (90.4%).

On the other hand, the two knowledge questions for which the highest percentages of respondents answered incorrectly were 1) "Pain during urination is a symptom of Schistosomiasis" (32.2% correct answers) and 2) "The most common symptom of Schistosomiasis is fever" (58.6% correct answers) (Table 2).

Table 2. Summary of knowledge about worm infections

Questions		**Correct n (%)**		
		CHWs	**Teachers**	**Total**
Schistosomiasis knowledge	**Schistosomiasis mean score (SD)**	**74.9 (16.3)**	**73.8 (17.1)**	**74.5 (16.62)**
Schistosomiasis is treatable at the health center (Yes)		434 (85.3)	310 (90.4)	744 (87.3)
You can transmit Schistosomiasis from open defecation (Yes)		454 (89.2)	316 (92.1)	770 (90.4)
Swimming in contaminated water can lead to Schistosomiasis (Yes)		490 (96.3)	320 (93.3)	810 (95.1)
Washing clothes in contaminated water can lead to Schistosomiasis (Yes)		454 (89.2)	265 (77.3)	719 (84.4)
You can get Schistosomiasis from eating unripe fruits (No)		352 (69.2)	254 (74.1)	606 (71.1)
You can contract Schistosomiasis through sexual intercourse (No)		331 (65)	259 (75.5)	590 (69.2)
Diarrhea is a symptom of Schistosomiasis (Yes)		395 (77.6)	304 (88.6)	699 (82)
The most common symptom of Schistosomiasis is fever (No)		318 (62.5)	181 (52.8)	499 (58.6)
Pain during urination is a symptom of Schistosomiasis (Yes)		205 (40.3)	69 (20.1)	274 (32.2)
STH knowledge	**STH mean score (SD)**	**83.4 (15)**	**81.6 (13.9)**	**82.6 (14.6)**
You can acquire STH from walking bare foot (Yes)		483 (94.9)	321 (93.6)	804 (94.4)
If you were cured from STH, you can never get it again (No)		384 (75.4)	236 (68.8)	620 (72.8)
Diarrhea is a symptom of STH (Yes)		434 (85.3)	301 (87.8)	735 (86.3)

Fever is the most common symptom of STH (No)	317 (63.2)	189 (55.1)	506 (59.4)
STH is hereditary (No)	432 (84.9)	316 (92.1)	748 (87.8)
You can acquire STH through direct skin contact (No)	453 (89)	300 (87.5)	753 (88.4)
You can get STH from drinking and eating contaminated water and food (Yes)	467 (91.7)	295 (86)	762 (89.4)
Overall mean score (SD)	78.6 (12.6)	77.2 (12.1)	78 (12.44)
Good knowledge level (≥80%)	288 (56.6)	173 (50.4)	461 (54.1)
Poor knowledge level (<80%)	221 (43.4)	170 (49.6)	3915.9)

4.1.3.Assessment of attitudes

The two statements which most participants strongly disagreed/disagreed with were 1)"STH can be best treated by traditional healers" (98.9%) and 2)"Schistosomiasis can be best treated by traditional healers" (98.5%). The two statements which most participants strongly agreed/ agreed with were 1)"I am an important contributor to the prevention of Schistosomiasis in my community" (97.2%) and 2)"I am an important contributor to the prevention of STH in my community" (97.8%) (Table 3).

Table 3. Summary of attitudes towards worm infections

Attitude statements	**Strongly agree/ agree N (%)**	**Strongly disagree/ disagree N (%)**	**P-value**
Deworming is helpful in treating Schistosomiasis	822 (96.5)	30 (3.5)	<0.001
The people in my community are at high risk of acquiring Schistosomiasis	579 (68)	273 (32)	<0.001
I am an important contributor to the prevention of Schistosomiasis in my community	828 (97.2)	24 (2.8)	<0.001
The frequency of mass drug administration against Schistosomiasis in Schools/community is enough	247 (29)	605 (71)	<0.001
Schistosomiasis can be best treated by traditional healers	13 (1.5)	839 (98.5)	<0.001
Deworming is helpful in treating STH	791 (92.8)	61 (7.2)	<0.001
The people in my community are at high risk of acquiring STH	721 (84.6)	131 (15.4)	<0.001
I am an important contributor to the prevention of STH in my community	833 (97.8)	19 (2.2)	<0.001
The frequency of mass drug administration against STH in Schools/community is enough	206 (24.2)	646 (75.8)	<0.001
STH can be best treated by traditional healers	9 (1.1)	843 (98.9)	<0.001

4.1.4. Assessment of practices

Most of the respondents 845 (99.2%) reported often or always washing hands before eating and 844 (99.1%) respondents reported encouraging children/people to wash their hands.

On the other hand, 298 (35%) respondents reported that they often or always drink untreated water, 81 (9.5%) reported that they often or always wash clothes or utensils in open water source and 62 (7.3%) reported that they often or always swim in rivers/lakes (Table 4).

Table 4. Summary of worm infections practices

Practices	**Often/always N (%)**	**Never/rarely N (%)**
I encourage children/ people to wash their hands	844 (99.1)	9 (0.9)
I wash my hands before eating	845 (99.2)	7 (0.8)
I drink untreated water	298 (35)	554 (65)
I swim in rivers/ lakes	62 (7.3)	790 (92.7)
I wash clothes or utensils in open water source	81 (9.5)	771 (90.5)

Most of the people also reported good sources of drinking water 822 (96.5%) - included tap water (52.1%) and borehole (44.4%). A small percentage of respondents drank from river/lakes (3.1%) and other sources (0.4%) (Table 5).

Table 5. Sources of water

Water sources		N (%)	
Good water source	Tap water	444 (52.1)	822 (96.5)
	Borehole	378 (44.4)	
Poor water source	River/Lakes	26 (3.1)	30 (3.5%)
	Swamps/Rock	4 (0.4)	

4.1.5. Association of demographic characteristics and knowledge

Using Chi-square to analyze the association between knowledge and demographic characteristics, five demographic characteristics showed statistical significance, set at 0.1 for the bivariate analysis. These were: occupation, age, district, years of experience and training (Table 6).

Table 6. Association of demographic characteristics and knowledge (Chi-square test)

		Poor knowledge (<80%)	**Good knowledge (≥80%)**	**Unadjusted OR (95% CI)**	**P-value**
Occupation	CHWs	221(43.4)	288 (56.6)	0.781(0.593-1.028)	**0.078***
	Teachers	170 (49.6)	173 (50.4)		
Age	18 – 35	124 (48.2)	133 (51.8)	NA	**0.094***
	36- 49	199 (47.5)	220 (52.5)		
	≥50	68 (38.6)	108 (61.4)		
Gender	Male	144 (46.5)	166 (53.5)	NA	0.804
	Female	247 (45.6)	295 (54.4)		
District	Nyamagabe	192 (42.9)	256 (57.1)	0.773(0.590-1.012)	**0.061***
	Rutsiro	199 (49.3)	205 (50.7)		
Marital status	Single	35 (45.5)	42 (54.5)	NA	0.285
	Married	344 (46.1)	402 (53.9)		

	Divorced	7 (63.6)	4 (36.4)		
	Widowed	5 (27.8)	13 (72.2)		
Education level	Primary	172 (43)	228 (57)	NA	0.421
	Secondary	196 (48.9)	205 (51.1)		
	University	12 (42.9)	16 (57.1)		
	Vocational training only	11 (50)	11 (50)		
	Literacy classes only	0	1 (100)		
Years of experience	≤ 5	147 (50.3)	145 (49.7)	1.313 (0.989-1.744)	**0.060***
	≥ 6	244 (43.6)	315 (56.4)		
Training	Trained	144 (37.7)	238 (62.3)	1.831 (1.391-2.410)	**<0.001***
	Not trained	247 (52.6)	223 (47.4)		
Year when they received training on worm infections	2016	9 (31)	20 (69)	NA	0.447
	2017	6 (46.2)	7 (53.8)		
	2018	12 (38.7)	19 (61.3)		
	2019	31 (38.8)	49 (61.3)		
	2020	48 (32.9)	98 (67.1)		
	2021	38 (45.8)	45 (54.2)		

The five factors which were significant in the bivariate analysis were then analyzed using logistic regression, and only training was found to have a statistically significant association with knowledge. Participants who were not trained were 0.487 less likely to have good knowledge compared to those who were trained (95% CI: 0.328 – 0.722) (P <0.001) (Table 7).

Table 7. Association of demographic characteristics and knowledge (logistic regression)

		Poor knowledge (<80%)	**Good knowledge (≥80%)**	**Adjusted OR (95% CI)**	**P-value**
Occupation	CHWs	221(43.4%)	288 (56.6%)	Ref	-
	Teachers	170 (49.6 %)	173 (50.4%)	0.791 (0.525 – 1.192)	0.263
Age	18 – 35	124 (48.2%)	133 (51.8 %)	Ref	
	36- 49	199 (47.5%)	220 (52.5%)	0.960 (0.587 – 1.1569)	0.870
	≥50	68 (38.6 %)	108 (61.4%)	0.808 (0.555 – 1.175)	0.264
District	Nyamagabe	192 (42.9) %	256 (57.1 %)	Ref	
	Rutsiro	199 (49.3 %)	205 (50.7 %)	1.150 (0.866 – 1.526)	0.334
Years of experience	≤ 5	147 (50.3%)	145 (49.7 %)	Ref	
	≥ 6	244 (43.6%)	315 (56.4%)	0.806 (0.569 – 1.141)	0.224
Training	Trained	144 (37.7%)	238 (62.3%)	Ref	
	Not trained	247 (52.6%)	223 (47.4%)	0.487 (0.328 – 0.722)	**<0.001***

4.1.6. Association of knowledge and attitudes

Only one attitude statement showed statistically significant association with knowledge when testing for the association between all the attitude statement and the knowledge category: "I am an important contributor to the prevention of Schistosomiasis in my community". Respondents who had good knowledge were 0.215 less likely to disagree with the statement, compared to those who had poor knowledge, with a P-value of <0.001 (Table 8).

Table 8. Association of knowledge and attitudes (chi-square test)

		N Agree (%)	N Disagree (%)	Unadjusted OR	P-value
Deworming is helpful in treating Schistosomiasis					
Knowledge	<80%	372 (95.1)	19 (4.9)	0.479 (0.225 – 1.018)	0.051
	≥80%	450 (97.6)	11 (2.4)		
The people in my community are at high risk of acquiring Schistosomiasis					
Knowledge	<80%	260 (66.5)	131 (33.5)	0.883 (0.662 – 1.179)	0.400
	≥80%	319 (69.2)	142 (30.8)		
I am an important contributor to the prevention of Schistosomiasis in my community					
Knowledge	<80%	372 (95.1)	19 (4.9)	0.215 (0.079 – 0.580)	**<0.001***
	≥80%	456 (98.9)	5 (1.1)		
The frequency of mass drug administration against Schistosomiasis in schools/community is enough					
Knowledge	<80%	113 (28.9)	278 (71.1)	0.992 (0.737 – 1.335)	0.957
	≥80%	134 (29.1)	327 (70.9)		
Schistosomiasis can be best treated by traditional healers					
Knowledge	<80%	4 (1)	387 (99)	0.519 (0.159 – 1.699)	0.402
	≥80%	9 (2)	452 (98)		
Deworming is helpful in treating STH					
Knowledge	<80%	365 (93.4)	26 (6.6)	1.153 (0.681 – 1.952)	0.595
	≥80%	426 (92.4)	35 (7.6)		
The people in my community are at high risk of acquiring STH					
Knowledge	<80%	329 (84.1)	62 (15.9)	0.934 (0.643 – 1.356)	0.720
	≥80%	392 (85)	69 (15)		
I am an important contributor to the prevention of STH in my community					
Knowledge	<80%	381 (97.4)	10 (2.6)	0.759 (0.305 – 1.886)	0.551
	≥80%	452 (98)	9 (2)		
The frequency of mass drug administration against STH in schools/community is enough					
Knowledge	<80%	97 (24.8)	294 (75.2)	1.065 (0.778 – 1.459)	0.693
	≥80%	109 (23.6)	352 (76.4)		
STH can be best treated by traditional healers					
Knowledge	<80%	4 (1)	387 (99)	(0.251- 3.535)	1.000
	≥80%	5 (1.1)	456 (98.9)		

4.1.7. Association of knowledge and practices

Only one practice statement showed significant association with knowledge when testing for the association between all the practice statement and the knowledge category: "I swim in rivers/ lakes". Respondents who had a good knowledge were 2.187 more likely to "often/always" swim in rivers/lakes compared to those who had poor knowledge, with a P-value of 0.006 (Table 9).

Table 9. Association of knowledge and practices (chi-square test)

		N Often/ always (%)	**N Never/ rarely (%)**	**Unadjusted OR**	**P-value**
I encourage children/ people to wash their hands					
Knowledge score	<80%	389 (99.5)	2 (0.5)	0.390 (0.78 – 1.983)	0.300
	≥80%	455 (98.7)	6 (1.3)		
I wash my hands before eating					
Knowledge score	<80%	389 (99.5)	2 (0.5)	0.469 (0.090-2.430)	0.462
	≥80%	456 (98.9)	5 (1.1)		
I drink untreated water					
Knowledge score	<80%	125 (32)	266 (68)	1.278 (0.962-1.698)	
	≥80%	173 (37.5)	288 (62.5)		0.090
I swim in rivers/ lakes					
Knowledge score	<80%	18 (4.6)	373 (95.4)	2.187 (1.242-3.850)	***0.006**
	≥80%	44 (9.5)	417 (90.5)		
I wash clothes or utensils in open water source					
Knowledge score	<80%	37 (9.5)	354 (90.5)	1.010 (0.638-1.598)	0.968
	≥80%	44 (9.5)	417 (90.5)		

4.2. Qualitative results

4.2.1. Community mobilization and sensitization by local leaders and CHWs improved the outreach of the deworming program

Village leaders were in charge of informing their community members about the program and encouraging them to have their children dewormed. In addition, local leaders oversaw and supervised the distribution of deworming tablets done by CHWs.

> *"I work hand in hand with community health workers daily to make sure that every child of our Village receives the medicine that the government provided. I am present from the start till the end of the program. I have to make sure that all tablets are distributed, that they are over… yes, I have to be there."* (IDI 3)

In case a child was missing during the time of distribution, the local leader would conduct a follow-up visit to the household to make sure that the child receives their tablet.

"*At the sites, we checked out if parents brought children to get tablets as encouraged during households' mobilization; and we could re-visit the ones we noticed did not come so that s/he brings the child the following day.*" (IDI 8)

4.2.2. Community members appeared to appreciate the decentralized deworming program and expressed the desire for expansion

The respondents perceived that the community members appreciated the introduction of the deworming program at village level as it made it easier for them to access the service within their reach without travelling long distances to the health centers.

> *"They are very receptive because they do not walk miles to access the program. They are very receptive and happy with the program."* (IDI 1)

According to the respondents, the community requested for adult deworming tablets so that they too should benefit from deworming. In addition, the respondents expressed the need for increasing the frequency of deworming children in order to improve their health status.

> *"My suggestion is... it is good that children get those deworming tablets. If advocacy can be done, adults also should be given tablets because they also have the same problem of worm infections. If there was the same program for adults, it could be good."* (IDI 5)

> *"My suggestion is that you can advocate so that the deworming tablets are available twice a year; that could be better. It should be twice a year and the distribution should continue to be done at the Village level, because, when it was done at the Cell level, it was not as effective as today at the Village level. There was a crowd of people, and the distance was longer, and in some instance, all children could not be served in a single day and parents were discouraged as the process interfered with their daily activities. Today, they are happier to get the service at the Village level as it is a decentralized program."* (IDI 1)

Respondents also reported that they noticed good health outcomes of children as a result of the deworming program which led to children not falling sick frequently and getting malnourished due to worm infestations.

> *"I mean, these tablets came on time because children had started to develop [enlarged] tummies, but after the deworming program, we can see the improvement. In fact, when the time of the program approaches, people are ready to get their children to receive deworming tablets."* (IDI 16)

> *"Yes, the impact is there because children have eliminated worms [in stool] and we realize a good growth development."* (IDI 16)

4.2.3. Complementary interventions to the deworming program

Local leaders in collaboration with CHWs conducted community sensitization sessions on hygiene as well as household visits to monitor hygiene practices.

> *"We encourage the community to always drink boiled water because unclean water is a host for worms. Another thing is…to encourage our people to have latrines, not to empty the bowels [defecate] in the outside in an open air because the waste contains worms that may get into the springs and rivers when it rains, and we may contract those when we use that water. Another thing is to encourage the community to have hygiene habits; hygiene of dishes, personal body hygiene and hygiene of foodstuff because poor hygiene in this stuff is also source of worm infections."* (IDI 17)

In view of improving household hygiene, community members, led by the local leaders, supported in building adequate latrines for those who could not afford them.

> *"For the households which have no latrines, we build those for them during communal works (Umuganda) and the Sector and District's Offices have a plan for that. The Umuganda of the Village builds latrines, and the Sector provides roofing materials."* (IDI 17)

4.2.4. Resistance and hesitance from caregivers were perceived as challenges to the deworming program.

Some respondents expressed that some caregivers did not adhere to the deworming program. Instead of the caregivers bringing the children to the deworming sites, they would choose to go out to their farms.

> *"When the community health workers come on time, they may also not find parents…that is the challenge. The parents come whenever they want, after farming activities."* (IDI 6)

According to one of the respondents, some caregivers were resistant to deworming, because it resulted in increased food consumption by the children, which they could not afford.

> *"The main reason they say is that those deworming tablets have adverse effects to their children. Another reason they say is that when a child has taken that tablet, s/he eats a lot and "I will not be able to find that food."* (IDI 10)

According to the respondents, some caregivers perceived their children to be healthy, and did not see the importance of deworming them.

> *"There are no adverse effects, but the understanding of the community members is different. Some might say, "my child is healthy, s/he is not sick, so I am not taking him/her anyway."* (IDI 11)

4.2.5. Poor water access was identified as a drawback in the prevention of worm infections.

Most of the respondents mentioned that their communities were facing an issue of poor access to safe water. This was described by geographical and financial barriers, as they have to move long distances to access water sources, and they had to pay for the water.

"About water…it is not yet fine, it is not yet good because, for instance in our Village there is no drinking water, people still have to take jerry cans and go to fetch water; what we do is to encourage them to boil water so that it is safe to drink." (IDI 5)

"Yes, it happens! It happens, the problem of low financial capacity exists, because when you tell a parent to give healthy food to their children or to adopt hygiene, it requires them to have money to buy soap or water, because in our Village there is water available but to access it people have to pay for it. This problem of low financial means then arises." (IDI, 8)

5. DISCUSSION

CHWs, teachers and local leaders are primary implementers of the national deworming program. There are limited studies in Rwanda that assess the KAP of CHWs and teachers, as well as the experiences of local leaders in the implementation of the program. The study revealed a gap in the knowledge of CHWs and teachers on worm infections, and a perceived appreciation of the community on the deworming program with a need to expand the scope of the deworming program to include adults.

5.1. Knowledge on worm infections

Results indicated that the knowledge related to worm infections among teachers and CHWs was not good, with an overall score of 78%. Moreover, only about half of the respondents (54.1%) had a good knowledge score, estimated at ≥80% (Bloom, 1956). The results also revealed a significant association between training and knowledge, with participants who had been trained having a higher knowledge on worm infections compared to those who had not been trained. Moreover, more than half of the participants (55.2%) had not received any prior training with regards to deworming. This gap in training was marked for teachers, among whom only 3.5% reported prior training compared to 72.7% among CHWs. Data from the RBC mentions that 42,000 CHWs were trained on common NTDs (RBC, 2019). Therefore, this might call for an assessment of the curriculum to ensure that specific training on worm infections is included and that enough training duration is allocated for participants to have a full understanding of these diseases. Furthermore, a pre and post training evaluation could help assess the knowledge gained by participants and provide further feedback on specific areas of the training that need strengthening (Shivaraju et al., 2017). Additionally, there is a need to ensure that teachers, who are key implementers of the program are also trained.

The participants had higher knowledge score on STH (82.63%) than Schistosomiasis (74.48%). This finding was similar to another study in Ivory Coast, where participants showed better knowledge on STH than Schistosomiasis (Acka et al., 2010). Only 32.2% of respondents recognized that pain during urination is a symptom of Schistosomiasis and about 30% of the respondents mistaken fever to be the most common symptom of Schistosomiasis. These findings were similar to other studies conducted in Yemen as well as Nigeria, both found that even though people had heard about Schistosomiasis, their knowledge on symptoms was generally low (Dawaki et al., 2015; Sady et al., 2015). Therefore, there is a need to educate people about the signs and symptoms of worm infections, with an emphasis on Schistosomiasis. This would serve in early identification of infected people in the community, who potentially put others at risk of infection.

5.2. Attitudes and misconceptions on worm infections

When asked if deworming was helpful in the prevention of schistosomiasis and STH, over 95% of the respondents responded positively. This attitude showed that CHWs and teachers were receptive of the program, as they believed it was helpful in preventing worm infections. Also, 98% of the respondents disagreed with the statement that worm infections can best be treated by traditional healers. This is different from another study conducted in Ivory Coast, where most participants perceived that both traditional and modern medicine could cure worm infections (Acka et al., 2010). In addition, the qualitative part of the study revealed that CHWs were in charge of sensitization and distribution of deworming tablets. Considering their receptive attitude towards the program, CHWs should be equipped with the necessary skills and knowledge to properly educate the population and successfully implement the program.

Overall, the deworming program was appreciated, but a need to increase the frequency of MDA was expressed. From the local leaders' perspectives, community members commended the decentralized deworming program as it had numerous health benefits for their children. Parents also appreciated the decentralized nature of the program for the eased access to the tablets, as they were provided within their villages. A study conducted on CHWs in Kenya revealed similar findings, whereby community members appreciated the MDA for schistosomiasis control due to its good health outcomes (Omedo et al., 2012). However, over 70% of survey respondents expressed the view that the frequency of MDA was not enough in their community. This was consistent with the findings from the qualitative part of the current study where many local leaders suggested that the frequency of MDA should be increased in areas where it was only conducted once annually. This calls for strengthening of the monitoring and evaluation of the program to ensure that the frequency MDA is in line with WHO standards (WHO, 2012). Additionally, according to the local leaders, community members expressed a need for adult deworming, as worm infections also affect adults. Studies have shown that adults especially due to occupational exposure from activities such as farming, could have higher prevalence of hookworm infections (Soares Magalhães et al., 2015). Therefore, the scope of the deworming program should be expanded to include adults.

Local leaders reported that some misconceptions and resistance from the community members posed a challenge to the implementation of the deworming program. One of the misconceptions was that their children were healthy and did not need any medications. Resistance to deworming was also found in other countries like Kenya where misconceptions about the tablets was found to cause reluctance (Omedo et al., 2012). Additionally, according to local leaders, one of the reasons why community members exhibited resistance to the deworming program was their inability to provide enough food to their children, as it was believed that deworming contributes to increased appetite. This was highlighted in a similar study conducted in Kenya where food insecurity posed a major challenge to MDA compliance (Omedo et al., 2012). Such misconceptions and resistance may become bottlenecks to the deworming program as they may hinder timely control and elimination of these worm infections. Therefore, there is a need to strengthen community sensitization programs, with an emphasis on these misconceptions as well as the impact of deworming on the health of their children. In addition, complementary programs such as kitchen gardens should be emphasized to address the issue of food insecurity.

5.3. Practices on worm infections

Most of the respondents drank water from good water sources such as water taps and boreholes. However, local leaders expressed that due to geographical and financial limitations to water access, many people had to walk long distances to reach these water sources and were required to pay to access water in certain areas. Access to safe water not only can impact on the prevalence, but also the intensity of re-infection after deworming (Njomo et al., 2017). Moreover, 35% of the survey respondents reported drinking untreated water. Although this percentage of people drinking from untreated water was lower than some other countries, the number was still alarmingly high (Nasr et al., 2013). Therefore, interventions to further improve access to safe water are needed. WASH interventions are important in the prevention of worm infections and therefore should be adopted to complement the deworming program (Campbell et al., 2017; Sacolo-Gwebu et al., 2019).

Unexpectedly, there was a negative correlation between swimming in rivers/lakes and the knowledge level of respondents about worm infections. Those who had good knowledge were two times more likely to swim in rivers/lakes compared to those who had poor knowledge. This finding was similar to another study conducted in Tanzania, which revealed that despite having knowledge of the risk of infection from water bodies, people still had a tendency to visit the lakes/rivers for recreational purposes (Munisi et al., 2017). In order to address this, official swimming locations should be marked and subjected to swimming regulations. Waters from these locations should be tested on a regular basis to fulfill all safety requirements.

5.4. Study limitations

This study had some limitations which should be considered when interpreting its findings:

Firstly, the practice score in this survey relied on self-reporting. This could have subjected the findings to desirability bias, especially when practices were not directly observed. Hence, this may affect the reliability. For future research, direct observation of participants' practices could be conducted to generate more reliable information.

Secondly, this study only interviewed local leaders. Future study to collect community members' perspectives and experiences towards the deworming program may generate different insights.

6. CONCLUSION AND RECOMMENDATIONS

This study aimed to assess the KAP of CHWs and teachers on deworming and explore the experiences and perspectives of local leaders in the national deworming program.

Findings from the study revealed that CHWs and teachers who received training, were two times more likely to have good knowledge compared to those who had not received training. Findings also showed that more CHWs had been trained on worm infections than teachers. Moreover, survey findings showed that having knowledge on risk of transmission was not sufficient to prevent respondents from swimming in rivers or lakes. Many survey respondents also reported drinking untreated water, which exposed them to worm infections.

Research findings from the IDIs revealed that community members appreciated the deworming program and expressed the need for its expansion to include adults and increase the frequency of MDA. Nonetheless, some community members were reported to exhibit resistance towards the program, due to some of their held misconceptions. In addition, findings from the IDIs revealed limitations to access clean drinking water, whereby community members had to move long distances to reach good water sources and had to pay for the water. Lastly, IDIs showed that food insecurity represented as a bottleneck to the deworming program.

Based on these findings, the following recommendations were made:

There is a need to strengthen the training program which has shown the potential to positively influence the knowledge of participants. Areas of emphasis in the training could be on signs and symptoms of worm infections for which many respondents seemed to be deficient, and on Schistosomiasis as participants had less knowledge compared to STH. Another measure that could help improve the effectiveness of the training could be pre and post training evaluations. Moreover, trainings should also be provided to teachers who have for the majority reported not having received training.

Given the tendency of people to swim in rivers/lakes, despite their knowledge on worm infections, interventions should be put in place to regulate swimming conditions through regular water testing and marked swimming locations.

Community education and sensitization should be targeted towards addressing various misconceptions, which make community members resistant or hesitant towards the deworming tablets. Examples of such misconceptions included parents thinking that healthy children do not need deworming tablets.

As suggested by local leaders, the scope of the program should be expanded to include adults as they are also exposed to worm infections, and this may put the children at risk of re-infections. Additionally, monitoring and evaluation of the deworming program should be strengthened to ensure that the frequency of MDA is in line with WHO recommendations in each locality.

There is also a need for complementary interventions to support the deworming program. First, WASH interventions should be intensified to address financial and geographical barriers to water access and minimize exposure to worm infections. Additionally, interventions such as kitchen

gardens should be emphasized at community level to address food insecurity, which presented as a challenge in the implementation of the deworming program.

Lastly, to complement this study, future research should be conducted to assess the experiences and perspectives of CHWs and teachers who implement the deworming program in Rwanda.

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Appendices

Appendix 1: Information and Consent Form

Project title: KAP of teachers and CHWs on deworming, and experiences of local leaders on the national deworming program in Rutsiro and Nyamagabe districts in Rwanda.

Study population: This study will be conducted in Nyamagabe and Rutsiro districts. Study participants will be schoolteachers, Community Health Workers as well as local leaders from both districts.

Principal Investigator:

Madalitso Ireen Mkata,

MGHD Student at the University of Global Health Equity,

Principle Investigator

Fernand Rwamwejo,

MGHD Student at the University of Global Health Equity,

Principle Investigator

Iliza Ndatinya Grace,

MGHD Student at the University of Global Health Equity,

Principle Investigator

This study is part of the MGHD program, and it will receive ethical approvals from IRB to comply with international research standards.

About this consent form

Dear participant,

Before you decide to participate in this research, it is important that you understand why this study is being conducted and what it implies. Please read the following information carefully and feel free to ask the researcher if you need any clarification or additional information. If you agree to participate in this study, you will be asked to sign this form.

Participation is voluntary

Participation in this study is fully dependent on your choice and you reserve the right to withdraw from this study at any time. Withdrawing from the study or not participating will not affect you in any way.

What should you know about this research study?

At the beginning of the study, the researcher will explain the study to you, and you will be able to ask questions. You are being asked to participate in this study as one of the key implementers of the national deworming program in your district.

What is the purpose of this project?

The purpose of this research is to assess the KAP of teachers and CHWs on deworming, as well the experiences and challenges of local leaders in Nyamagabe and Rutsiro districts.

Objectives:

- To assess the KAP of teachers and CHWs on deworming by July 2021.
- To understand the experiences of local leaders in the implementation of the national deworming program by July 2021.

Study procedures:

The study will be conducted in the following key steps:

- Teachers and CHWs will respond to questions on survey questionnaires.
- Responses will be collected and analyzed by the team of researchers.
- Local leaders in the community will be interviewed.
- Survey response time for every teacher will be 20-30 minutes.
- In-depth interview for every local leader will take 30-60 minutes.
- The entire study will be conducted within a six-week period.

Number of people who will take part in this research.

Approximately 870 people will take part in this research.

Procedure for participation in this project

The procedure to participate in this interview is as follows:

Every study participant will be reached by the researcher within their location. Upon consent to participate in the study, they will sign an informed consent, to start the study process.

Survey response time for every participant will be approximately 20-30 minutes, while in-depth interviews will be approximately 30-60 minutes.

Possible risks or discomforts related to taking part in this project.

We do not anticipate any risks to the participants taking part in the study.

Possible benefits of taking part in this project

Your participation in this research will not earn you any direct benefit, however, we hope that this study will inform best practices for the national deworming program to eradicate worm infections in your community.

Compensation

No compensation will be provided for participating in this study.

What will I have to pay for if I participate in this research?

It will not cost you anything to participate in this research.

Can my taking part in the research end early?

You may decide that not to continue in the research at any time without it being held against you.

If I take part in this project, how will my privacy be protected? What happens to the information you collect?

To protect your privacy, data such as names or telephone numbers will not be collected. In addition, the data collected will be stored in a secured database that can only be accessed by the research team on a UGHE laptop with a protected password. Personal data will not be available to anyone outside the research team. The research team will ensure that your responses will be kept confidential and not used against you in any way. Also, data generated will be managed in accordance with the University of Global Health Equity IRB regulations and destroyed after 10 years.

Data collected, including your identifiable information, may be seen by the UGHE Institutional Review Board (IRB) that oversees the research. In addition, we may also share your information related to this study with other parties including translators, thesis committee, and/or other federal agencies as applicable.

If I have any questions, concerns, or complaints about this project, who can I talk to?

This study is conducted by the University of Global Health Equity. The primary investigators are Fernand Rwamwejo, Grace Iliza Ndatinya and Madalitso Mkata.

To contact the research team:

Fernand Rwamwejo: Tel: *+250783777496,* Email*: fernand.rwamwejo@student.ughe.org*

Madalitso Mkata: Tel: *+265991229703*, Email*:* madalitso.mkata@student.ughe.org

Iliza Ndatinya Grace: *+250787771404,* Email*: grace.ndatinya@student.ughe.org*

You can contact the research team for the following reasons:

1. If you have questions, concerns, or complaints.
2. If you would like to talk to the project team.
3. If you think the project has harmed you.
4. If you wish to withdraw from the study.
1. If you wish to withdraw from the study.

This research has been reviewed by the University of Global Health Equity Institutional Review Board. If you wish to speak with someone from the IRB for ethical considerations regarding this study, please contact the IRB at irb@ughe.org, telephone: 0788316894 or Office of Human Research Administration (OHRA) at Kigali Heights Building, 5th floor, Kacyiru, Kigali, P.O. Box 6955, Rwanda for any of the following reasons:

If your questions, concerns, or complaints are not being answered by the research team.
If you cannot reach the research team.
If you want to talk to someone besides the research team.
If you have questions about your rights as a research participant, or;
If you want to get information or provide input about this research.

Statement of consent

1. You have had the opportunity to ask questions and received answers that were satisfactory.
2. You agree to participate in this research project.

I have read the information in this consent form including risks and possible benefits. All my questions about the research have been answered to my satisfaction. I understand that I am free to withdraw at any time without penalty or loss of benefits to which I am otherwise entitled.

SIGNATURE

Your signature below indicates your permission to take part in this research

_____ _____

Full name and signature of the participant Date and location

_____ _____

Full name and signature of the person Date and location

requesting consent

☐ I consent to have the interview audio-recorded

Kinyarwanda version of consent form

Inyandiko yo Kwemera Kwitabira Ubushakashatsi

Umutwe w'umushinga: Ubushakashatsi ku bumenyi, imyitwarire hamwe n'imikorere y'abarimu n'abajyanama b'ubuzima ku mitangire y'ibinini bivura inzoka zo mu nda, no kumenya ibijyanye n'uruhare rw'abayobozi bo mu nzego z'ibanze muri gahunda y'igihugu yo gutanga ibinini bivura inzoka zo mu nda mu turere twa Rutsiro na Nyamagabe.

Abatumirwa: Abaturage bazibandwaho ni abarimu, abajyanama b'ubuzima ndetse n'abayobozi bo mu nzego z'ibanze bo mu turere twa Rutsiro na Nyamagabe.

Itariki: Tariki 17 Werurwe, 2021

Itsinda ry'ubushakashatsi:

Madalitso Ireen Mkata,

Umunyeshuri ukurikirana impamyabumenyi mu bijyanye no gutanga serivisi z'ubuzima ku isi muri kaminuza ya Global Health Equity (UGHE)

Fernand Rwamwejo,

Umunyeshuri ukurikirana impamyabumenyi mu bijyanye no gutanga serivisi z'ubuzima ku isi muri kaminuza ya Global Health Equity (UGHE)

Iliza Ndatinya Grace,

Umunyeshuri ukurikirana impamyabumenyi mu bijyanye no gutanga serivisi z'ubuzima ku isi muri kaminuza ya Global Health Equity (UGHE)

Ubu bushakashatsi buri muri gahunda y'ibisabwa mu kubona impamyabumenyi mu bijyanye no gutanga serivisi z'ubuzima ku isi kandi buzemezwa n'akanama gashinzwe ubushakashatsi n'amahame mbwiriza muco ka UGHE, hagendewe ku myitwarire mpuzamahanga ingenga ubushakashatsi.

Aderesi: UGHE, Campus ya Butaro, Akarere ka Burera - u Rwanda

Amakuru ku byerekeye iyi nyandiko:

Mutumirwa,

Mbere yo kwemera kugira uruhare muri ubu bushakashatsi, mugomba gusobanukirwa no kuzirikana ibikubiye muri iyi nyandiko, kubera ko ikubiyemo amakuru y'ingenzi abafasha mu guhitamo kwitabira cyangwa kutitabira ubu bushakashatsi. Murasabwa gusoma iyi nyandiko mwitonze, mugasaba ibisobanuro itsinda ry'abashakashatsi mu gihe bibaye ngombwa. Niba mwemeye kwitabira ubu bushakashatsi, murasinya kuri iyi nyandiko.

Kwitabira ubu bushakashatsi ni uburenganzira bwanyu.

Mufite uburenganzira bwo guhitamo kwitabira cyangwa se kutitabira ubu bushakashatsi. Mu gihe muhisemo kwitabira ubushakashatsi, mwemerewe kwisubira mugahitamo kuva muri ubu bushakashatsi igihe icyaricyo cyose. Guhitamo kutitabira ubu bushakashatsi cyangwa guhitamo guhagarika uruhare rwanyu muri ubu bushakashatsi nta ngaruka n'imwe bizabagiraho.

Ni iki nkwiye kumenya kuri ubu bushakashatsi?

Mbere yo gutangira ubushakashatsi, ushinzwe gukusanya amakuru arabasobanurira ibijyanye n'ubu bushakashatsi. Mwemerewe kubaza ibibazo mu gihe mutasobanukiwe neza ibikubiye muri ubu bushakashatsi. Mwatumiwe kwitabira ubu bushakashatsi nk'umwe mubashyira mu bikorwa gahunda y'igihugu yo gutanga ibinini bivura inzoka zo mu nda mu karere mutuyemo.

Intego y'ubu bushakashatsi ni iyihe?

Intego y'ubu bushakashatsi ni ugusuzuma ubumenyi, imyitwarire hamwe n'imikorere y'abarimu n'abajyanama b'ubuzima ku mitangire y'ibinini bivura inzoka zo mu nda, no kumenya ibijyanye n'uruhare rw'abayobozi bo mu nzego z'ibanze muri gahunda y'igihugu yo gutanga ibinini bivura inzoka zo mu nda mu turere twa Rutsiro na Nyamagabe.

Ibigamijwe:

- Gusesengura ubumenyi, imyitwarire n'imikorere y'abarimu n'abajyanama b'ubuzima ku mitangire y'ibinini bivura inzoka zo mu nda muri Rutsiro na Nyamagabe bitarenze Nyakanga 2021.

- Gusobanukirwa imbogamizi n'ibitekerezo by'abayobozi b'inzego z'ibanze mu ishyirwa mubikorwa rya gahunda y'igihugu yo gutanga ibinini bivura inzoka zo mu nda mu turere twa Rutsiro na Nyamagabe bitarenze Nyakanga 2021.

Ibigize ubushakashatsi:

Ubushakashatsi buzakorwa mu buryo bukurikira:

1. Abarimu n'abajyanama b'ubuzima bazasubiza ibibazo byanditse.
2. Ibisubizo bizakusanwa byigwe n'itsinda ry'abashakashatsi.
3. Abayobozi b'inzego z'ibanze bazabazwa ibibazo mu biganiro
4. Igihe cyo kubazwa kuri buri mwarimu/mujyanama w'ubuzima ni iminota (20-30)
5. Ikiganiro cyo kubazwa kuri buri muyobozi w'urwego rw'ibanze kizamara iminota (30-60).
6. Ubushakashatsi buzakorwa mu igihe cy'ibyumweru bitandatu.

Ubushakashatsi buzitabirwa n'abantu bangahe?

Abantu bagera kuri 870 nibo bazitabira ubu bushakashatsi.

Ubushakashatsi buzitabirwa mu buhe buryo?

Ubushakashatsi buzitabirwa muri ubu buryo:

Buri mutumirwa uzitabira ubu bushakashatsi azagerwaho n'ushinzwe gukusanya amakuru mu mudugudu atuyemo. Mu gihe umutumirwa yemeye kwitabira ubushakashatsi, azasinya iyi nyandiko ubushakashatsi bubone gutangira. Igihe cyo kubazwa ibibazi kuri buri mwarimu/ mujyanama w'ubuzima ni iminota 20-30. Ikiganiro na buri muyobozi w'urwego rw'ibanze kizamara iminota 30-60.

Ni izihe ngorane zishobora guturuka mu kwitabira ubu bushakashatsi ?

Nta ngaruka zishobora guturuka mu kwitabira ubu bushakashatsi.

Ni izihe nyungu zaturuka mu kugira uruhare muri uyu mushinga?

Umusanzu wanyu muri ubu bushakashatsi uzafasha mu kunoza gahunda y'igihugu yo gutanga ibinini bivura inzoka zo mu nda hagamijwe gukumira izi ndwara mu karere mutuyemo.

Nzahabwa ingurane yo kwitabira ubu bushakashatsi ?

Nta ngurane cyangwa indishyi zizaboneka muri ubu bushakashatsi.

Nsabwe kwishyura iki kugira ngo nitabire ubu bushakashatsi?

Ntacyo musabwe kwishyura kugirango mugire uruhare muri ubu bushakashatsi.

Ese uruhare rwanjye muri ubu bushakashatsi rushobora kurangira hakiri kare?

Mushobora guhitamo kuva muri ubu bushakashatsi igihe icyo aricyo cyose kandi nta gihano cyangwa ingaruka byabaviramo.

Ni gute ubwiru bw'amakuru yanjye bwite buzarindwa? Amakuru azakusanywa azakoreshwa gute?

Mu kurinda, ubwiru bw'amakuru yanyu bwite, amakuru bwite nk'amazina cyangwa numero ya telefoni ntibizakusanywa. Ikindi kandi, amakuru azakusanywa azabikwa kuri mudasobwa zigendanwa zirinzwe n'umubare w'ibanga za UGHE, aho itsinda ry'ubushakashatsi ryonyine ariryo rizaba ryemerewe kubona aya makuru. Nta makuru bwite azahabwa umuntu n'umwe utari mw'itsinda ry'abashakashatsi. Itsinda ry'ubushakashatsi rizemeza ko ibisubizo byanyu bizaba ari ibanga kandi ko nta ngaruka bizabagiraho mu buryo ubwo aribwo bwose. Amakuru yakusanyijwe azacungwa hakurikijwe amabwiriza y'akanama gashinzwe ubushakashatsi n'amahame mbwirizamuco ka UGHE kandi asibwe nyuma y'imyaka 10.

Amakuru yakusanyijwe, harimo ayatuma mumenyekana, ashobora kuzabonwa n'akanama gashinzwe ubushakashatsi n'amahame mbwirizamuco ka UGHE. Mubyongeyeho, amakuru yanyu ajyanye n'ubu bushakashatsi ashobora kubonwa n'abandi bantu bafite uruhare muri ubu bushakashatsi bakubiyemo abasemuzi, komite ishinzwe amasomo yacu, cyangwa izindi nzego za leta mu gihe byaba ari ngombwa.

Niba mfite ibibazo, impungenge, cyangwa ibirego bijyanye nubu bushakashatsi, ninde navugana nawe?

Ubu bushakashatsi buri gukorwa na kaminuza y'ubuzima bwiza ku isi (University of Global Health Equity). Abayoboye ubu bushakashatsi ni Fernand Rwamwejo, Grace Iliza Ndatinya, na Madalitso Mkata.

Mushobora kuvugana n'itsinda ry'ubushakashatsi mukoresheje ibi bikurikira:

Fernand Rwamwejo: *+250783777496, fernand.rwamwejo@student.ughe.org*

Madalitso Mkata: *+265991229703, madalitso.mkata@student.ughe.org*

Iliza Ndatinya Grace: *+250787771404, grace.ndatinya@student.ughe.org*

Mwakwegera aba bantu ku mpamvu zikurikira:

1. Ufite ibibazo, impungenge cyangwa ibirego,
2. Wifuza kuvugisha itsinda ry'ubushakashatsi,
3. Wakomerekejwe n'ubushakashatsi,
4. Wifuza kuva muri ubu bushakashatsi.

Ubu bushakashatsi bwasuzumwe n'akama gashinzwe ubushakashatsi n'amahame mbwirizamuco ka UGHE. Muramutse mukeneye kuvugana n'aka kanama ku byerekeye imyitwarire n'amahame mbwiriza muco agenga ubu bushakashatsi, mwakwandikira, irb@ughe.org, cyangwa mugahamagara kuri telephone igendanwa: 0788316894, mushobora kandi kwegera ibiro

bishinzwe ubushakashatsi ku bantu (OHRA) ku cyicaro gikuru cya UGHE ku Kacyiru: mu nyubako ya Kigali Heights, igorofa rya 5, kigali, Rwanda, ku mpamvu zikurikira:

1. Niba ibibazo, impungenge cyangwa ibirego byawe bitasubijwe mubushakashatsi,
2. Niba utabashije kuvugana n'itsinda ry'ubushakashatsi,
3. Niba wifuza kuvugisha undi muntu usibye itsinda ry'ubushakashatsi,
4. Niva ufite ibibazo ku burenganzira bwawe nkuwagize uruhare mubushakashatsi cyangwa,
5. Niba wifuza amakuru cyangwa gutanga umusanzu kur ubu bushakashatsi

Itangazo

● Mwagize amahirwe yo kubaza ibibazo kandi mwanyuzwe n'ibisubizo mwahawe.

● Muremera kugira uruhare muri ubu bushakashatsi ku bushake bwanyu

Ndemeza ko nasomye kandi numvise ibikubiye muri iyi nyandiko yo kwitabira ubushakashatsi. Nagize amahirwe yo gusuzuma iyi nyandiko, kubaza ibibazo kandi nahawe ibisobanuro bihagije. Ndumva ko mfite uburengazira bwo kuva muri ubu bushakashatsi igihe icyo ari cyo cyose, kandi ko nta ngaruka bizangiraho izo arizo zose.

Umukono wanyu usobanuye ko mwemeye kugira uruhare muri ubu bushakashatsi

_____ _____

Amazina n'umukono by'umutumirwa Itariki n'aho bikorewe

_____ _____

Amazina n'umukono by'usaba uburenganzira Itariki n'aho bikorewe

☐ Ndemera y'uko iki kiganiro cyafatwa amajwi

Appendix 2: Data collection tools

Demographics:

Age:	
Sex:	□ Male □ Female
Address:	District: Sector: Cell: Village:
Profession/Occupation:	□ CHW □ Teacher
Highest level of education attained:	□ None □ Primary □ Secondary □ University □ Vocational training only □ Literacy classes only
Marital status:	□ Single □ Married □ Divorced □ Widowed
Years of experience as a teacher/CHW:	
Were you trained on deworming?	□ Yes □ No
Year when you were last trained on deworming:	□ 2016 □ 2017 □ 2018 □ 2019 □ 2020 □ 2021

KAP for CHWs and teachers

Knowledge

Section 1. Schistosomiasis	**Yes**	**No**	**I don't know**
1. Schistosomiasis is treatable at the health center	□	□	□
2. You can transmit Schistosomiasis from open defecation	□	□	□
3. Swimming in contaminated water can lead to Schistosomiasis	□	□	□
4. Washing clothes in contaminated water can lead to Schistosomiasis	□	□	□
5. You can get Schistosomiasis from eating unripe fruits	□	□	□
6. You can contract Schistosomiasis through sexual intercourse	□	□	□

7. Diarrhea is a symptom of Schistosomiasis	□	□	□
8. The most common symptom of Schistosomiasis is fever	□	□	□
9. Pain during urination is a symptom of Schistosomiasis	□	□	□
Section 2: Soils Transmitted Helminths (STH)	**Yes**	**No**	**I don't know**
10. You can acquire STH from walking bare foot	□	□	□
11. If you were cured from STH, you can never get it again.	□	□	□
12. Diarrhea is a symptom of STH	□	□	□
13. Fever is the most common symptom of STH	□	□	□
14. STH is hereditary	□	□	□
15. You can acquire STH through direct skin contact	□	□	□
16. You can get STH from drinking and eating contaminated water and food	□	□	□

Attitudes

Section 1: Schistosomiasis	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
17. Deworming is helpful in treating Schistosomiasis	□	□	□	□
18. The people in my community are at high risk of acquiring Schistosomiasis	□	□	□	□
19. I am an important contributor to the prevention of Schistosomiasis in my community	□	□	□	□
20. The frequency of mass drug administration against Schistosomiasis in schools/community is enough	□	□	□	□
21. Schistosomiasis can be best treated by traditional healers	□	□	□	□

Section 2: STH	Strongly agree	Agree	Disagree	Strongly disagree
22. Deworming is helpful in treating STH	□	□	□	□
23. The people in my community are at high risk of acquiring STH	□	□	□	□
24. I am an important contributor to the prevention of STH in my community	□	□	□	□
25. The frequency of mass drug administration against STH in schools/community is enough	□	□	□	□
26. STH can be best treated by traditional healers	□	□	□	□

Practices	Never	Rarely	Sometimes	Always
27. I encourage children/ people to wash their hands	□	□	□	□
28. I wash my hands before eating	□	□	□	□
29. I drink untreated water	□	□	□	□
30. I swim in rivers/ lakes	□	□	□	□
31. I wash clothes or utensils in open water source	□	□	□	□
32. What is the common source of drinking water you use?	□ River/Lakes □ Tap water □ Boreholes □ Others, please specify_____			
33. What method do you use to treat drinking water?	□ None □ Boiling			

	□ Filtering □ Others, please specify_____

Ibibazo mu Kinyarwanda

Imyirondoro

Imyaka:	
Igitsina:	□ Gabo □ Gore
Aho utuye:	Akarere: Umurenge: Akagali: Umudugudu:
Umwuga:	□ Umujyanama wubuzima □ Umwarimu
Urwego ruhanitse rw'uburezi mwabashije kugeraho:	□ Ntarwo □ Abanza □ Ayisumbuye □ Kaminuza □ Ay'imyuga gusa □ Amashuri yo gusoma no kwandika gusa
Irangamimerere:	□ Ingaragu □ Uwashatse □ Uwatandukanye □ Umupfakazi
Imyaka umaze ukora nk' umwarimu/umujyanama w'ubuzima:	
Hari amahugurwa wahawe mu kurwanya indwara z'inzoka zo mu nda?	□ Yego □ Oya
Umwaka uherutse guhabwamo amahugurwa k z'inzoka zo mu nda:	□ 2016 □ 2017 □ 2018 □ 2019 □ 2020 □ 2021

Ibibazo bigenewe abajyanama b'ubuzima /abarimu

Ubumenyi

Igice cya mbere: Bilariziyozi	**Yego**	**Oya**	**Simbizi**
4. Bilariziyozi yavurirwa ku kigo nderabuzima	□	□	□
1. Wakwanduza Bilariziyozi binyuze mu kwituma hanze	□	□	□
2. Wakwandura Bilariziyozi wogeye mu mazi yanduye	□	□	□
3. Kumesera imyenda mu mazi yanduye bishobora gutera Bilariziyozi	□	□	□
4. Kurya imbuto ziteze byagutera Bilariziyozi	□	□	□
5. Wakwandurira Bilariziyozi mu mibonano mpuzabitsina	□	□	□
6. Impiswi ni ikimenyetso cya Bilariziyozi.	□	□	□
7. Ikimenyetso nyamukuru cya Bilariziyozi ni uguhinda umuriro.	□	□	□
8. Kwihagarika ukababara ni ikimenyetso cya Bilariziyozi.	□	□	□
Igice cya kabiri: Inzoka zo mu nda zandurira mu butaka		**Oya**	**Simbizi**
9. Kugenda utambaye inkweto bishobora gutuma wandura inzoka zo mu nda zandurira mu butaka	□	□	□
10. Iyo wavuwe inzoka zo mu nda zandurira mu butaka ugakira, ntiwakongera kuzirwara	□	□	□
11. Impiswi ni ikimenyetso cy'inzoka zo mu nda zandurira mu butaka	□	□	□
12. Guhinda umuriro ni ikimenyetso nyamukuru cy'inzoka zo mu nda zandurira mu butaka	□	□	□
13. Inzoka zo mu nda zandurira mu butaka ni indwara ihererekanywa mu muryango	□	□	□
14. Inzoka zo mu nda zandurira mu butaka zandurira mu gukoranaho k'umubiri	□	□	□
15. Kunywa amazi mabi n'ibiryo bidasukuye bishobora gutuma wandura inzoka zandurira mu butaka	□	□	□

Imyifatire

Igice cya mbere: **Bilariziyozi**	**Ndemeranya cyane**	**Ndemeranya**	**Sinemeranya**	**Sinemeranya na gato**
1. Gutanga ibini bivura inzoka zo mu nda ni ingenzi mu kurwanya Bilariziyozi	□	□	□	□
2. Abantu bo mu gace ntuyemo bafite ibyago byinshi byo kwandura Bilariziyozi.	□	□	□	□
3. Mfite uruhare rukomeye mu gukumira Bilariziyozi mu gace ntuyemo.	□	□	□	□
4. Inshuro imiti ivura Bilariziyozi itangwa mu mashuri/mu gace ntuyemo zirahagije	□	□	□	□
5. Ubuvuzi bwa gakondo nibwo buryo bwiza bwo kuvura Bilariziyozi	□	□	□	□
Igice cya kabiri: Inzoka zo mu nda zandurira mu butaka	**Ndemeranya cyane**	**Ndemeranya**	**Sinemeranya**	**Sinemeranya na gato**
6. Gutanga ibinini bivura inzoka zo mu nda bifasha mu kurwanya inzoka zo mu nda zandurira mu butaka	□	□	□	□
7. Abantu bo mu gace ntuyemo bafite ibyago byinshi byo kwandura inzoka zo mu nda zandurira mu butaka	□	□	□	□
8. Mfite uruhare rukomeye mu gukumira inzoka zo mu nda zandurira mu butaka mu gace ntuyemo	□	□	□	□

9. Inshuro imiti ivura inzoka zo mu nda zandurira mu butaka itangwa mu mashuri/mu gace ntuyemo zirahagije	□	□	□	□
10. Ubuvuzi bwa gakondo nibwo buryo bwiza bwo kuvura inzoka zo mu nda zandurira mu butaka	□	□	□	□

Imikorere

Igice cya mbere: Bilariziyozi	**Ntanarimwe**	**Gakeya**	**Rimwe na rimwe**	**Kenshi**
1. Nkangurira abana/abaturage gukaraba intoki	□	□	□	□
2. Nkaraba intoki mbere yo gufata amafunguro	□	□	□	□
3. Nywa amazi adatetse	□	□	□	□
4. Nihe ukunze gukura amazi yo kunywa?	□ Ku mugezi/ Mu kiyaga □ Kuri robine □ Kuri nayikondo □ Ahandi, sobanura_____			
5. Ni ubuhe buryo ukoresha mugusukura amazi yo kunywa?	□ Ntabwo □ Kuyateka □ Kuyayungurura □ Ubundi buryo, sobanura_____			
Igice cya kabiri: **Inzoka zo mu nda zandurira mu butaka**	**Ntanarimwe**	**Gakeya**	**Rimwe na rimwe**	**Kenshi**
6. Noga mu kiyaga/ mugezi	□	□	□	□

7. Mesera imyenda cyangwa nogereza ibyombo mu kiyaga/ mugezi	□	□	□	□

Local leaders' qualitative interview

1. As a village leader, can you describe your experience working in the decentralized deworming program?
2. As village leader, what challenges, if any, have you faced while working in the decentralized deworming program?
3. What reactions have you observed or received from your community on the decentralized deworming program?
4. What interventions, apart from deworming, have you implemented or tried to implement in your community to address/combat intestinal worms?
5. What recommendations do you have on how the decentralized deworming program can be improved?
6. Is there anything else you would like to share with us regarding this program that might not have been discussed during this interview?

Ibibazo byagenewe abayobozi bo mu nzego z'ibanze

1. Nk'umuyobozi w'umudugudu, mwadusobanurira uburyo gahunda yo gutanga ibinini by'inzoka zo mu nda mu mudugudu muyoboye yagenze?

2. Nk'umuyobozi w'umudugudu, ni izihe mbogamizi mwaba mwarahuye nazo muri gahunda yo gutanga ibinini by'inzoka zo mu nda mu mudugudu muyoboye?

3. Mwadusobanurira uko mwabonye abaturage bakiriye gahunda yabegerejwe yo gutanga ibinini bivura inzoka zo mu nda?

4. Usibye iyi gahunda yo gutanga ibinini bivura inzoka zo mu nda, ni izihe ngamba zindi mwaba mwarafashe cyangwa mwarageragejeje gushyira mu bikorwa mu mudugudu muyoboye kugirango mubashe gukumira indwara z'inzoka zo mu nda?

5. Mubona ari iki cyakorwa kugira ngo iyi gahunda yo gutanga imiti ivura inzoka zo mu nda irusheho kunozwa?

6. Haba hari ikindi mwaba mwifuza kudusangiza kuri iyi gahunda twaba tutaganiriyeho muri iki kiganiro?