DOI: 10.1111/tmi.14098

RESEARCH ARTICLE

Identification of training needs in schistosomiasis research to build capacity for schistosomiasis control in Uganda

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Funding information
Fogarty International Center, Grant/Award Number: D71 TW12564

Abstract

Background: Schistosomiasis is the leading cause of fatal upper gastrointestinal bleeding among adults in East Africa. The prevalence among school-aged children in villages along the Albert–Nile shoreline in North-Western Uganda is estimated at 85%. Efforts to control schistosomiasis in low- and-middle-income countries remain limited due to an incomplete understanding of the pathogenesis, disease manifestations, transmission mechanisms, preventive measures and interventions. In addition, there is insufficient capacity to analyse, model and predict relevant clinical case management systems, biological interventions and disease control efforts. We conducted a needs assessment for schistosomiasis research training at academic and research institutions in Uganda to inform the development of a structured training programme to build capacity to conduct locally relevant research to control the disease.

Methods: Using an online survey, we collected data on training needs, potential trainees, available resources including local and international collaborations, as well as priority areas for schistosomiasis research and training at academic and research institutions in Uganda. Data were analysed and presented in frequency tables and figures.

Results: Overall, schistosomiasis had the lowest number of studies conducted, based on the studies approved by research ethics committees at the two leading medical schools in Uganda: Makerere University College of Health Sciences (MakCHS) and Mbarara University of Science and Technology (MUST) between 2016 and 2022. The top ranked schistosomiasis focus areas of interest, by scientists at MakCHS, MUST, the Vector Borne and Neglected Tropical Diseases Division of the Ministry of Health and the Uganda Virus Research Institute (UVRI), were schistosomiasis prevention and transmission, vector biology, diagnostics, treatment and clinical trials, respectively. The top ranked training needs were schistosomiasis prevention and control, research ethics, data analysis, epidemiology and research methods (quantitative and qualitative), malacology, infectious diseases modelling, scientific writing and communication skills.

Conclusion: Priority areas for schistosomiasis research and training will be utilised to develop a robust, collaborative, multidisciplinary schistosomiasis research training programme, to increase the critical mass of scientists with the competencies required to design, execute and utilise schistosomiasis biology, clinical, laboratory and epidemiology research to advance disease control interventions and minimise/eliminate schistosomiasis-associated morbidity and mortality in sub-Saharan Africa.

SDG4: Quality eduacation

SDG3: Good Health and Wellbeing

KEYWORDS
capacity building, malacology, research training, schistosomiasis, sub-Saharan Africa, Uganda

INTRODUCTION

Neglected tropical diseases (NTDs), including schistosomiasis, are diseases of poverty that affect over a billion people worldwide and largely affect the most vulnerable, marginalised populations in tropical and subtropical regions [1]. Africa bears the brunt of poverty-related and NTDs, including schistosomiasis and the associated complications of portal hypertension and fatal upper gastrointestinal bleeding. Schistosomiasis is a neglected water-based, vector-borne disease transmitted indirectly through freshwater snails. Schistosomiasis is estimated to affect more than 240 million individuals globally, with 700–800 million people at risk of infection [2–4] with over half of the infections occurring in children [3, 5, 6]. In sub-Saharan Africa, approximately 280,000 deaths per year have been attributed to schistosome infections and their complications [7]. Since the description of schistosomiasis in Uganda in the 1950s [4, 8], the disease remains endemic, with an estimated 25% of the population infected [3] and 50% at risk [9].

Schistosoma mansoni (Sm) is highly prevalent in Uganda. Most cases are found around the Great Lakes and River Nile, and prevalence among school-aged children in villages along the Albert-Nile shoreline in the district of Pakwach, North-western Uganda, was estimated at 85%. The disease is associated with complications of peri-portal fibrosis and portal hypertension, making it the leading cause of upper gastrointestinal bleeding among adults in the region [10]. Severity and determinants of the disease among populations living along Lake Victoria regions in Central and Eastern Uganda [10, 11] are less understood in comparison with the disease around Lake Albert and the Albert Nile in West and Northeastern Uganda. Efforts to control schistosomiasis in low- and middle-income countries (LMICs) remain limited due to incomplete understanding of the pathogenesis, disease manifestations and transmission mechanisms, inadequate preventive measures and interventions, and insufficient capacity to analyse, model and predict relevant clinical case management systems, biological interventions and disease control efforts in the LMIC context.

We hypothesise that the limited critical mass of schistosomiasis scientists and health professionals in sub-Saharan Africa largely contributes to the lack of capacity to conduct locally relevant research to inform therapeutics, surveillance, vaccination, and disease control, and sustainable research training programmes to improve the management of schistosomiasis in areas where it is endemic. Moreover, the COVID-19 pandemic exposed the vulnerability of primary and tertiary health care systems globally, more so in LMICs where the scarcity of trained scientists was coupled with limited infrastructure and local products to handle the epidemic [12, 13]. Therefore, we conducted a needs assessment for schistosomiasis research training at academic and research institutions in Uganda to inform the strategic development of a structured training programme to build capacity to conduct locally relevant research to control schistosomiasis in endemic regions.

This study is in line with the recent Kigali declaration on combating NTDs, where academic and research institutions committed to foster interdisciplinary research (including biomedical and socio-behavioural sciences) to build a better understanding across disciplines of NTDs; to influence policy and practice towards achieving the WHO 2030 targets on NTDs, including schistosomiasis [1, 14].

METHODS

To estimate the amount of schistosomiasis research conducted at academic institutions in Uganda, we analysed the proportion of schistosomiasis research approved by research and ethics committees among all research protocols submitted at two leading medical schools in Uganda, namely Makerere University College of Health Sciences (MakCHS) and Mbarara University of Science and Technology (MUST) between 2016 and 2022. In addition, we conducted an online survey to stakeholders in schistosomiasis training, research, and disease control at MakCHS, MUST, Uganda Virus Research Institute, and the Vector Borne and Neglected Tropical Diseases Division (VB/NTD) at the Ministry of Health to determine the availability of potential trainees and trainers, priority areas of interest in schistosomiasis research, as well as priority training needs and expertise required to develop a vibrant schistosomiasis research training programme.

Study procedures and participants

An online survey software (Survey Monkey) was administered by email to institutional/departmental leaders, research and ethics committee secretariats, potential trainers and trainees in all disciplines, the Ministry of Health VB/NTD team and scientists at the Uganda Schistosomiasis Multidisciplinary Research Centre (U-SMRC) at UVRI. The study team followed up participants with email reminders and phone calls as needed to encourage completion of the survey. In addition, consultative meeting(s) were held at each of the sites to engage all stakeholders interested in schistosomiasis research to brainstorm on training needs, available resources, resources that need to be developed, existing local and international collaborators, as well as collaborators that need to be brought on board, including representation from the affected communities. Data was analysed and presented in descriptive frequency tables and figures.

Ethical considerations

All participants provided written informed consent to participate, and the study was approved by the School of Medicine Research and Ethics Committee and the Uganda National Council for Science and Technology.

RESULTS

Demographic characteristics

The majority (78%) of respondents were 31–50 years old, and they included research scientists, academic university faculty, and graduate trainees (Table 1).

Schistosomiasis studies approved by Research Ethics Committees at academic institutions

Overall, schistosomiasis research had the lowest number of studies approved between 2016 and 2022, based on the record of studies approved by research ethics committees at the two leading medical schools, MakCHS and MUST, relative to other research areas (Figure 1).

TABLE 1 Demographic characteristics of schistosomiasis training and research stakeholders in a training needs assessment in Uganda.

Schistosomiasis training and research stakeholders	Total ($N = 23$), *n* (%)
Institution	
MRC/UVRI and LSHTM Uganda Research Unit	9 (39.1)
Mbarara University of Science and Technology	12 (52.2)
Vector-Borne and Neglected Tropical Diseases	2 (8.7)
Ministry of Health	
Age of the respondents	
18–30 years	2 (8.7)
31–50 years	18 (78.3)
51–70 years	3 (13.0)
Job description	
Research Scientist	13 (56.5)
Faculty at a University	10 (43.5)
Graduate student	7 (30.4)
Ministry of Health Employee	1 (4.3)
Research administrator	1 (4.3)
Other	4 (17.4)
Currently conduct training programmes relevant for any training in schistosomiasis research and control	
No	9 (39.1)
Yes	14 (60.9)

Potential trainees and faculty

We identified several graduate training programmes at Masters' and doctoral levels in multiple disciplines including clinical medicine, medical microbiology, parasitology, clinical epidemiology, immunology, bioinformatics and socio-behavioural science (Table 2) as sources for potential trainees and trainers.

Proposed training courses

MakCHS, MUST and UVRI listed all the courses that need to be mounted to build capacity for specific competencies of scientists with the ability to conduct relevant multidisciplinary schistosomiasis research, train and supervise trainees to become experts with the capacity to generate and disseminate data on schistosomiasis burden, prevention and control. These would also engage communities to participate in advocacy for schistosomiasis control, as well as carry out research on the discovery of medicinal products to contribute to schistosomiasis therapeutics (Table 3). The participating institutions listed the available faculty and scientists, laboratory, clinical and field research infrastructure that will be leveraged to support a structured schistosomiasis training programme (Table 4). These can be leveraged to provide trainers, research funding, and elective attachments for trainees' in specific areas of interest.

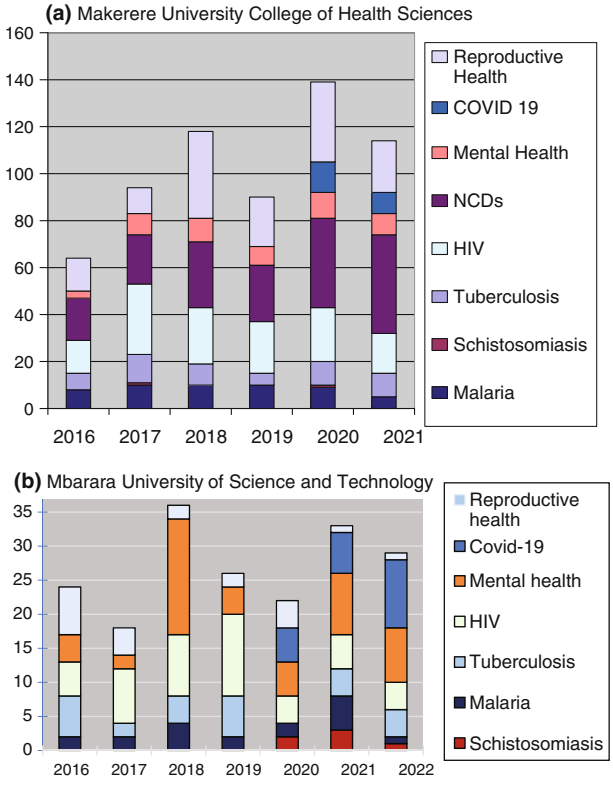

FIGURE 1 Quantity of schistosomiasis research approved at two leading medical schools in Uganda (Makerere University College of Health Sciences and Mbarara University of Science and Technology between 2016 and 2022.

TABLE 2 Training programmes to contribute trainees and training platforms for the schistosomiasis research training programme in Uganda.

Institution	Existing training programme[a]
Mbarara University of Science and Technology Average number trainees-60	• MSc in Microbiology and Parasitology • Bachelor of Science with Education (Biological) • Bachelor of Science in Public Health • MSc in Biology (Microbiology and Parasitology) • Master of Science in Biology (Natural Resources Ecology, Conservation and Management)
MRC/UVRI and LSHTM[b] Uganda Research Unit Average number of trainees-30	• PhD trainees eligible for post-doctoral positions • Introductory Bioinformatics (IBT) as part of the H3ABioNet research consortium • Training in Statistics (with focus on use with R or Stata) • Good Participatory Practice and Stakeholder Engagement Trainings • Social Science Research Methods training
Vector Borne and Neglected Tropical Diseases, Ministry of Health	• Medical Entomology and Parasitology
Makerere University College of Health Sciences Average number of trainees −200	• Master of Medicine programmes in Medicine, Paediatrics, Surgery, Medical Microbiology, Medical Pathology • Master of Science programmes in Immunology and Molecular Biology, Bioinformatics, Bioethics, Clinical Epidemiology and Public Health • Doctoral programmes in Medicine, Health Sciences, Clinical Epidemiology, Immunology and Molecular Biology, and Bioinformatics

[a]The existing academic programmes provide potential trainees and a training platform for the upcoming schistosomiasis research training programme.
[b]Medical Research Council/Uganda Virus Research Institute and London School of Hygiene and Tropical Medicine Uganda Research Unit.

TABLE 3 Training courses that are needed to enhance schistosomiasis research training and disease control.

Institution	Proposed training areas	Outputs
Makerere University & Mbarara University of Science and Technology	Neglected tropical diseases Laboratory diagnostics for schistosomiasis including xenomonitoring Schistosomiasis epidemiology Schistosomiasis and the one-health approach Socio-behavioural science and community engagement Natural therapeutics in managing schistosomiasis GIS and remote sensing for schistosomiasis research Citizen science approach in schistosomiasis research Health communication to promote schistosomiasis control Preventive chemotherapy for schistosomiasis Quantitative and qualitative research methods	Build a critical mass of experts with skills for research, prevention and control of schistosomiasis Train trainers Disseminate data on schistosomiasis burden, prevention and control Conduct in-service training Community engagement Research and discovery of medicinal products for schistosomiasis control
MRC/UVRI and LSHTM Uganda Research Unit & Makerere University	Big data analyses Schistosomiasis epidemiology Introductory genetics and genomics Parasite immunology, immunological assays Clinical trials: methodologies Good participatory practices and stakeholder engagement Data analysis (data base design, management, analysis and reporting) Schistosomiasis diagnostics Schistosomiasis messaging for prevention	Pipelines Collaborative multidisciplinary and multi-institutional schistosomiasis research groups
Vector Control Division, Makerere University and Uganda Virus Research Institute	Malacology, schistosomiasis and its morbidities Molecular characterisation of schistosomes and the intermediate hosts Morphological and molecular characterisation of snails	Vibrant snail biology and schistosomiasis vector control research groups

Priority research areas and training needs

The top-ranked focus areas of interest by scientists at MakCHS, MUST, VB/NTD and UVRI were schistosomiasis prevention and transmission, vector biology, diagnostics, treatment and clinical trials respectively (Figure 2). Similarly, the top-ranked training needs were courses in schistosomiasis prevention and control, research ethics, data analysis, epidemiology and research methods (quantitative and qualitative), malacology, infectious disease modelling, scientific writing and communication skills. Other key research competences needed include statistical computing and data management, schistosomiasis immunology, diagnostics and therapeutics, vaccine studies and research leadership (Figure 3).

DISCUSSION

Low quantity and spectrum of schistosomiasis research

Despite several descriptive studies of schistosomiasis in Uganda in the 1950s [8, 15–17], schistosomiasis is under-

TABLE 4 Resources that can be leveraged for the proposed schistosomiasis training programme.

Institution	Resources available and anticipated contribution to schistosomiasis research training	
Mbarara University of Science and Technology	Faculty staff in biology/parasitology and medical laboratory science Experienced biostatisticians Equipment for sampling of snails, water parameters and parasite detection including water analysis instrumentation, microscope, and cercariae shedding equipment	• Medical laboratory science department for diagnostics, • Pharmacy department for prescribing medicine • Faculty of science for vector control • Laboratory space with staff for practical training sessions • Department of biology will contribute towards vector control • Multidisciplinary team will participate in the various aspects of the training
MRC/UVRI and LSHTM Uganda Research Unit & Makerere University	Social science experts Computing infrastructure Bioinformatics and genomics expertise Training rooms and laboratory space Experienced biostatisticians Experienced immunologists	• Experienced scientists in schistosomiasis field including clinical trials will facilitate specific courses and supervise graduate students • Host practical sessions and laboratory placements
Vector Control Division	Malacologists Parasitology and snail laboratories Knowledgeable teaching staff	• Field attachment centre for parasite identification and community interventions • Aquarium and experimental laboratories for trainees

represented in the research conducted by faculty and trainees at Uganda research and training institutions. At both MakCHS, the largest and oldest medical school in East Africa, and MUST, the second oldest medical school in the country, the field of schistosomiasis had the lowest number of studies approved by the research and ethics committees between 2016 and 2022. The low numbers of schistosomiasis studies at academic institutions may be attributable to the limited engagement of graduate students' research in the subject, which in turn contributes to the limited contribution of academic institutions to the much-needed innovations in schistosomiasis disease control in regions where the disease is endemic. We also hypothesise that the limited number and spectrum of schistosomiasis-focused studies is due to the limited capacity for advanced research training of scientists to undertake advanced study designs to further understand the disease's pathogenesis and genomics of parasite populations. There is increasing demand for African scientists with skills to lead basic, translational, immunological and bioinformatics research of tropical diseases in the region, including schistosomiasis. The scarcity of scientists with these advanced research skills and techniques imperils the regional health agenda to control major endemic diseases [18], especially those that may not always be of international priority. There is therefore an urgent need to attract, train, and retain more researchers in the field of schistosomiasis if proper management, control and subsequent eradication of the disease are to be effected.

Potential trainees and trainers

Our results show a significant number of potential trainees that would incorporate schistosomiasis research training in existing graduate training programmes in biology, medical entomology, epidemiology, infectious diseases, microbiology, pathology, statistics, immunology and bioinformatics. These are missed opportunities to build multidisciplinary capacity for schistosomiasis research training that would be harnessed through a structured research training programme. Although research groups in schistosomiasis exist at MakCHS, MUST, UVRI and VCD, these groups acknowledge significant gaps in knowledge and skills in epidemiology, case management, parasitology, malacology and prevention research; and recognise the tremendously low numbers of researchers in these fields. Particularly, prevention and control of schistosomiasis require readily available and knowledgeable multidisciplinary groups of researchers with proficiency to more accurately identify research priority areas and design/implement relevant clinical trials for therapeutics and potential vaccines to protect the most-at-risk populations in endemic regions and manage the short- and long-term complications of the disease. In addition, there are already several collaborators globally working with MakCHS, MUST, UVRI and VCD with schistosomiasis research expertise and infrastructure that can be leveraged to optimise the research training experience through expert trainers, mentors and elective placements [19].

Uganda has welcomed international schistosomiasis research initiatives through the Ministry of Health Vector Control Division (VCD) since the 1950s. The majority of schistosomiasis studies were descriptive; describing disease burden and complications [3, 4, 6] seminal parasitology [15], immunology, clinical, epidemiological and sociological aspects [15, 17], as well as malacology, human and parasite genetics and, most recently, vaccine studies, including an initiative to establish controlled human infection studies for schistosomiasis to accelerate vaccine research [20–22]. Similarly, a few schistosomiasis therapeutics studies, including praziquantel (PZQ) mass drug administration (MDA) and its impact in populations, have been conducted within schistosomiasis control areas in Africa. Whole-genome sequence data was generated from 174 individual miracidia collected from both children and adults from fishing communities on islands in

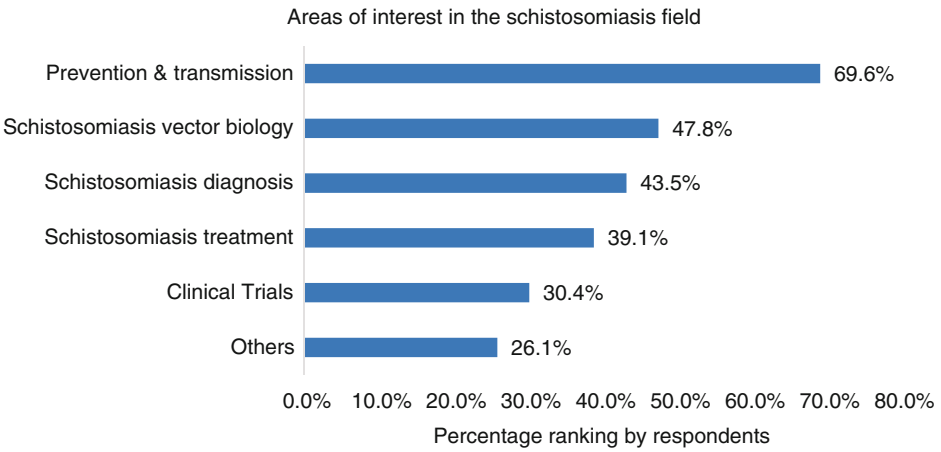

FIGURE 2 Areas of interest in the schistosomiasis field, as ranked by stakeholders at academic and research institutions in Uganda.

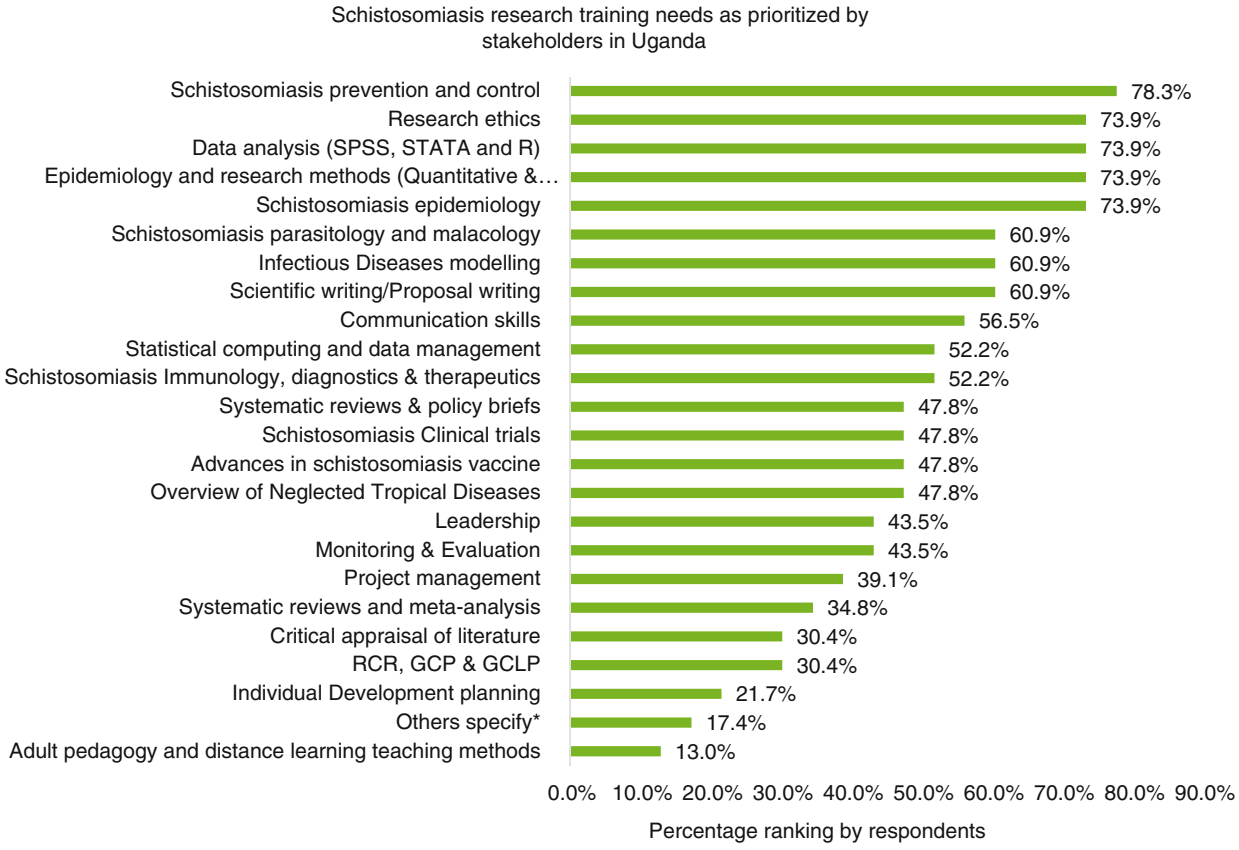

FIGURE 3 Schistosomiasis research training needs as prioritised by stakeholders in Uganda.

Lake Victoria in Uganda after either annual or quarterly MDA with PZQ over 4 years, showing diverse parasite populations on the lakeshore [6, 7, 23]. These studies provide a rich basis for research and collaboration, which can underpin collaborative training at these academic and research institutions.

Priority research training needs

As ranked by scientists at MakCHS, MUST, VB/NTD and UVRI, priority research training needs that included schistosomiasis prevention and transmission, vector biology, diagnostics, treatment and clinical trials, are all aligned to the WHO 2030 roadmap for NTDs. Similarly, skills in research ethics, research methods (quantitative and qualitative), infectious disease modelling, data analysis, scientific writing and communication skills are much needed to produce scientists that can develop multidisciplinary approaches towards the elimination of schistosomiasis and other NTDs [1]. Other key research competencies that include statistical computing and data management, schistosomiasis immunology, diagnostics and therapeutics, vaccine studies and research leadership need

to be considered to enhance existing graduate training curricula and empower graduates to contribute to alleviating NTD-associated morbidity and mortality. Development of comprehensive educational curricula on the prevention, treatment and control of NTDs aligns with the commitment of academic and research institutions at the Kigali declaration on uniting to combat NTDs [14] to build the capacity and excellence of the health and research workforce, as well as attract and consolidate a critical mass of professionals to work on NTDs in endemic countries.

Noteworthy is the fact that this study was limited to the identification of current and potential research training capacity rather than the analysis of schistosomiasis research outputs, which would require a systematic review of all published schistosomiasis research, including a meta-analysis where required. Skilled schistosomiasis research trainees would conduct such studies as part of the highly ranked training needs of advanced research methods, systematic reviews, data analysis, and infectious disease modelling that will be delivered through a structured schistosomiasis research training programme.

CONCLUSION

Findings from this training needs assessment will inform the development of an innovative research training and career enhancement programme for multidisciplinary scientists and health research professionals to strengthen the capacity to conduct independent, sustainable research in schistosomiasis and engagement of communities where 50% of Ugandans are at risk of exposure. A structured schistosomiasis research training programme would leverage existing graduate training programmes, experience, and infrastructure that have been highlighted through this assessment.

ACKNOWLEDGEMENTS

The authors acknowledge all the staff and scientists at MakCHS, MUST, VCD and UVRI who participated in this schistosomiasis research training needs assessment. Research reported in this publication was supported by the Fogarty International Center under Award Number D71 TW12564. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

CONFLICT OF INTEREST STATEMENT

The authors declare that they do not have any conflicts of interest.

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How to cite this article: Nakanjako D, Egesa M, Byakwaga H, Tolo CU, Byaruhanga AM, Beinamaryo P, et al. Identification of training needs in schistosomiasis research to build capacity for schistosomiasis control in Uganda. Trop Med Int Health. 2025;30(4):314–21. https://doi.org/10.1111/tmi.14098