Training-Transfer Program for Rapid Schistosomiasis Diagnosis by CTMS and MIF Methods in the Kingdom of Eswatini, 2018

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Abstract

Schistosomiasis is still endemic in the Kingdom of Eswatini and the school-age children are the most at-risk groups, however, the prevalence among the schoolchildren of Swaziland has been long lacking actual survey. The" *Schistosomiasis haematobium* identification training-transfer program, implemented in the Kingdom of Eswatiani, actually detected *schistosoma* infection in the urine of Swazi school-age children, thereby providing the systematic ability and teaching training of local personnel for identification and screening of schistosomiasis, then establishing the baseline about the reference data of schistosomiasis. This program is from effective prevention measures to avoid the harm of schistosomiasis infection to children. The overall results showed that the education program accompanied with relevant technology transfer training, which really assisted the Swazi clinical examiners to strengthen the independent screening ability of schistosomiasis and intestinal parasitic infections. In the course, the local clinical examiner operated the Chamber-Tube Microscopic Slide System (CTMS) and MIF methods which both commonly used in Taiwan Disease Control Agency and hospitals, to significantly improve the clinical diagnosing and prevention capabilities of schistosomiasis and other intestinal parasites of Swaziland. The program is mainly executed by the teachers and staffs of the Tropical Medical Center, Taipei Medical University in Swaziland, and closely cooperates with the members of Swaziland Health Laboratory Services, Swaziland National Blood Transfusion Service and National Bilharzia Worm Control Program. In addition to establish good relations with multiunit, we were further familiar to the cooperation mode with the official institutions of Swaziland. The samples collection commissioned to the National Bilharzia Worm Control Program not only shortened the preparation time and simplified the related administrative procedures, but also made the workshop training smoother. After the examined results come out, the data of the parasite infection obtained by each test are immediately reported back to the Worm Control Program, so as to quickly implement the follow-up clinical treatment and deworming issues. The cooperation is benefited to more effectively prepare the deworming for schistosomiasis and intestinal parasites of Swazi primary schools in the future.

Overall, the urine and fecal examinations of primary school children in each province were respectively tested and trained by CTMS and MIF methods, which effectively

improved the ability of examiners from the local hospitals, medical clinics and facility for identifying *schistosoma* eggs and other worm eggs. In addition, the trainees gave a high satisfaction of total course with an average of 95 points or more. At the same time, the participants agreed the course is helpful the future examination and research work, and also agreed that the medical laboratory should introduce these two new diagnostic techniques. The results will contribute to the promotion of new diagnostic methods in the future. The urine test results showed that the total *schistosoma* infection of the Swazi primary school children was still as high as 11.4% (30/264), and the positive rate of the 5-12 years-age group was 12.3% (27/219). In the fecal tests, there were no eggs of *Schistosoma mansoni* found. On the other hand, the total infection rate of protozoa was still as high as 37.6% (97/258), among which the positive rate of the age group greater than 13 years old was 45.5% (20/44), higher than the positive rate of 5-12 years-age group, 36.0% (77/214). This result shows that people in the Kingdom of Eswatini, especially the rural areas, are still exposed to the high risk of intestinal protozoa infection. This program tries to further promote the technique and the experience of parasites screening and controlling in Taiwan to the Kingdom of Eswatini, and enhances the international status and importance of Taiwan in Africa or even the world. Through the cooperation among the TMU parasite team and Swaziland Health Laboratory Services, Swaziland National Blood Transfusion Service and National Bilharzia Worm Control Program, we will actually solve the problems faced by Swaziland in the prevention of tropical diseases. To pragmatically highlight the contribution of TMU and Taiwan in the health care system is very important for our diplomatic dilemma, or even affect whether we can be smoothly integrated into the field of international health such as WHO in the future.

Ⅰ. Background and purpose

Of the 17 neglected tropical diseases (NTDs) identified by the World Health Organization (WHO), 11 were caused by parasitic infections. These diseases still ravage more than 140 developing countries, threatening the lives and health of about one billion people around the world (Lo et al., 2017; Mutapi et al., 2017). With the development of globalization and the impact of global warming, tropical diseases are no longer confined to old geographical areas, but began to threaten other countries such as Europe, United States, and Japan et al. Therefore, although these developed countries are not in tropics, still attach great importance to the study of tropical medicine and parasitology, and actively invest a lot of people and funds to make relevant study flourish and extend its tentacles to tropical regions, e.g. Africa, Asia, Central and South America. As a result, these countries have also taken a lead in research areas such as public health, infectious diseases and tropical medicine, while also greatly strengthening the influence in international organizations. Schistosomiasis is still one of the major public health problems in the world today. WHO ranks it as the second most important parasitic disease worldwide. According to statistics, about 200 million people get infected and most of them in Africa, of which 20 million have serious symptoms and about 600 million people at risk of *schistosoma* infection (Chitsulo et al., 2000; Gryseels et al., 2006). The goal of the 2012 London Declaration for NTDs, under the auspices of the WHO Department of NTDs, is based on the diagnosis of the egg numbers in feces or urine, to reduce the prevalence of severe infection of schistosomiasis to less than 1% (Lo et al., 2017).

Schistosomiasis ravages most of the sub-Saharan Africa and the Nile Valley in Egypt and Sudan. Just in sub-Saharan Africa, an estimated 100 million school-age children (ages 6-14) need treatment for schistosomiasis (Mutapi et al., 2017). The process of *schistosoma* infection is that the cercaria invade into the final host skins by contacting with water, and rapidly move through the lungs into the liver and develop into adult worms, then migrate to the bladder venous plexus or mesenteric veins for lay-egging. Female adults produce up to hundreds of eggs per day. These eggs pass to different body tissues depending on the *schistosoma* species, e.g. *Schistosoma haematobium* eggs cause lesions in the bladder, while *Schistosoma mansoni* eggs will affect the liver and intestinal tissues. During the course of the infection, the different stages of *schistosoma* cause markedly varied patterns of inflammatory responses in their hosts.

The immunopathology of infection consists of inflammation of the skin (cercaria dermatitis) and granulomatous inflammation in response to the tissue-trapped parasite eggs (cystitis or chronic hepatitis) (Freedman, 1997; Gryseels et al., 2006). *Schistosoma haematobium* Infection induces ureteral and intravesical ulcers and polyp lesions, cause symptoms including dysuria, frequent urination, and especially hematuria. However, chronic diseases may evolve into hydronephrosis by bladder fibrosis or calcification, and increase the risks of chronic renal failure and bladder cancer. Among untreated patients with *Schistosoma haematobium*, 41-100% of infected children were found to have mild hematuria, with a total hematuria rate of 97% and an upper urinary tract lesion of 2-62%. On the other hand, *Schistosoma mansoni* eggs may deposit in the hepatic micro vessel plexus or penetrate the intestinal wall, which lead to liver fibrosis and cirrhosis, hepatosplenomegaly, etc.; or cause bacterial infection of the abdominal cavity, induce peritonitis, ascites and other discomfort. (Barsoum, 2013; MacDonald et al., 2002; Pearce and MacDonald, 2002)。

Previous reports have shown that people infected with schistosomiasis in Swaziland are about 230,000, including *Schistosoma haematobium* and *Schistosoma mansoni* (Chitsulo et al., 2000). The report of the Swazi Ministry of Health and Social Welfare in 2004 shows that schistosomiasis are still prevalent in the country (Kunene, 2004). Recent reports also found that since 1986, the prevalence of schistosomiasis in Swaziland has been estimated at 25% with few significant changes in decades. The national prevalent rate remained at 25.6% in 2003 and at 26.5% in 2010, compared to 22.6% in 2012. Among, the prevalence of *Schistosoma haematobium* is 15.5% while that of *Schistosoma mansoni* is about 6.4% (Lai et al., 2015). According to the data of 2016 WHO, there are about 100,000 school-age children in Eswatini who need prophylactic treatment for schistosomiasis, and nearly 200,000 people in all population (WHO, 2016). Principal investigator previously found that the prevalence of *Schistosoma haematobium* was much higher in the rainfall-less part of the eastern Lowveld region (11.4%) than in the western Highveld region (0.6%). It may be due to the lower coverage of the drug control program for schistosomiasis in there (Maseko et al., 2016). In 2009, principal investigator, Dr. Sukati and Dr. D'Lamini also surveyed the children *schistosoma* infection rate in the Siphofaneni rural area of Lowveld province. Overall, the incidence of morbidity of *Schistosoma haematobium*

was significantly higher in female (10.5%) than in male (1.4%). The prevalence of preschool children (≤5 years old) (15.3%) was significantly higher than that of population aged ≥19 (2.6%). However, most of the surveyed people were from residents living in slum areas and do not seem to fully represent the current prevalence of the schoolchildren in Swaziland. In addition, there has been no actually investigated to the *Schistosoma mansoni* infection. Therefore, this program wants to explore the infection status of both *Schistosoma haematobium* and *Schistosoma mansoni* in schoolchildren, and establish the baseline of the reference data to schistosomiasis infection of Swaziland, so as to develop effective prevention measures and to prevent the harm of schistosomiasis in children.

The current diagnostic criteria for schistosomiasis are based on the detection of eggs in urine or feces. The measures such as the elimination of intermediate host snails and the praziquantel treatment of schistosomiasis have all depended on actual diagnosis of the prevalence in endemic regions (Bergquist, 2002; Mutapi et al., 2017). Improvements in diagnostic efficacy will be benefited to overall schistosomiasis control because of the adverse effects of excessive use of molluscicides on ecosystems and the measures to reduce the burden of drug abuse. Correct diagnosis is the key to effective disease control. However, due to the lack of accurate and inexpensive diagnostic tools, it is difficult to effectively control schistosomiasis (Bergquist, 2002; Hamilton et al., 1998). Traditional diagnostic methods are labor intensive, not only time-consuming but also cumbersome to operate. The principal investigator cooperated with Dr. Sukati in 2012, to investigate the *schistosoma* infection of high school students in Manzini, Shiselweni and Lubombo provinces, the southern part of Swaziland by The "the Chamber-Tube Microscopic Slide System, CTMS", and found an increase in the rate of *schistosoma* infection in Swaziland. Given the limited medical resources, the logistical and technical barriers associated with the diagnostic rate of parasite microscopy are also critical for disease screening in developing countries of Africa. Current use of syringe-membrane filtration in Swaziland to detect *Schistosoma haematobium* eggs in urine is workable but as compared to the CTMS that used in the urine sediment test in major hospitals of Taiwan, the syringe filtration method is more cumbersome and expensive, and may become heavy economic burdens for the African developing countries. Therefore, this program will compare the advantages and disadvantages of these two diagnostic

methods, in order to promote the CTMS diagnostic method applied to the schistosomiasis prevention and control in Eswatini.

The Taiwan government has actively promoted international medical assistance for many years. The purpose is not only to accelerate the integration of Taiwan with the world and enhance international status, but also helps international friends to improve their medical and health systems through medical diplomacy. Except to actively participating in international medical assistance, collecting and analyzing foreign emerging and recurring disease hazards in response to climate change, researches on relevant epidemic prevention strategies such as epidemic prevention and treatment has become one of the priorities of the government's Implementation. The performance of Taipei Medical University in international medical research services has always been outstanding. For a long time, we have actively expanded international service, exchanges and cooperation, and established a diversified development context. Since 2009 and 2010, medical services were provided for long-term medical missions in the Kingdom of Eswatini of South Africa and the Sao Tome and Principe of West Africa. The short-term parasite research team led by Prof. Fan began from 2009 to Swaziland and Sao Tome, respectively, to conduct an epidemiological investigation in parasitic infections in primary school children, and in prevalence of women trichomoniasis and HPV. In addition to promoting the "SY Feces Examination Apparatus For Parasite Ova Only, CFEA-P" and "Merthiolate-Iodine-Formaldehyde Sedimentation Method, MIF" that both recommended by Taiwan CDC, for the diagnosis of intestinal parasites eggs, even smaller protozoa, the educational training on parasitic infections and identification of intestinal parasite eggs are also carried out locally each year to enhance local diagnostic capabilities. Taiwan has made great achievements in the prevention and treatment of tropical medical diseases. Therefore, in order to cultivate talents in Taiwan's tropical disease research and greatly enhance the international academic status, it is urgent to invest heavily in research and administration of tropical medicine-related professionals.

In order to encourage young Taiwanese scholars to explore African parasitology, the principal investigator in 2009-2011 lead the team with the Swazi National Clinical Laboratory Center and the National Bilharzia Worm Control Program to perform "An epidemiological study of the population infections in Kingdom of Eswatini for intestinal parasites, schistosomiasis and neurotropic parasites" program. In addition to

the profound medical research experience of tropical diseases in Africa, the research team is most important to have the opportunity to communicate with the relevant personnel in Swaziland, and to obtain the relevant information of WHO's parasitic health control. The related epidemiological investigation report has provided to the Swazi Ministry of Health to establish benchmark data, and the result report were also submit to the WHO as a reference for parasitic control. Moreover, the research team and Dr. Sukati and Ms. D'Lamini published five SCI paper on the epidemiological study of schistosomiasis and neurotropic parasitic infections in the schoolchildren of Swaziland (Fan et al., 2012; Liao et al., 2011; Chu et al., 2010; Liao et al., 2010; Liao et al., 2009). Under the aim of the Center for Tropical Medicine, we will engage in the integration of relevant medical resources, combine academic teaching and tropic researches, and promote screening, diagnosis and treatment of tropical diseases to enhance the cooperative research partnership of Taiwan with international tropical medicine. The results of assisting our diplomatic relationship to improve medical and research are fruitful.

Therefore, the project is intended to assist the Kingdom of Eswatini to build "Diagnosis-Treatment-Tracking System for *Schistosoma* infection of Schoolchildren", and establish a training program for the ability of parasite examiners. "The Tropical Medicine Center of Taipei Medical University in Swaziland" and "Swaziland Health Laboratory Services" is main training centers. Swazi Ministry of Health, Swazi Ministry of Education, Mrs. Sindisiwe Dlamini, Director of Swaziland Health Laboratory Services, and Mrs. Gugu Maphalala, Technical Director of Swaziland National Blood Transfusion Service, are consultants and coordinators. The teachers and staff of the Tropical Medicine Center of Taipei Medical University are the main executive personnel, provincial public health nurses are collaborative personnel and the parasitic related prevention and treatment personnel in various provincial hospitals and outpatient centers are the main training subjects. Building the ability of screening and identification personnel for the local schistosomiasis, constructing a large-scale screening of *Schistosoma haematobium* and *Schistosoma mansoni* for schoolchildren and investigating latest epidemic situation of schistosomiasis in Swaziland were performed as future control benchmarks. In addition, Taiwan's CTMS will be introduced for *schistosoma* diagnosis with the localized concept, and the difference between this method and the current diagnostic method will be compared to obtain the

feasibility assessment of promoting the CTMS system into the Kingdom of Eswatini. The Republic of South Africa is the largest economy in southern Africa, and Prof. Fan had gone to Mozambique in 2013 to visit Prof. Emilia, director of the parasite department at University Eduardo Mondlane; Dr. Nald, chairman of the institute for the control of intestinal parasites at Mozambique Ministry of Health, and talked about the possibility of MOU signing for the parasite screening and prevention cooperation between Taiwan, Swaziland and Mozambique. So it is hoped that through this program, Taiwan's technique and experience in screening and controlling parasites will be further extended to the Republic of South Africa, the Kingdom of Eswatini and the Republic of Mozambique, to raise Taiwan's international status in South Africa and the world.

Ⅱ. Participating name list and their responsibility

Prof. Chia-Kwung Fan, Supervisor of *S. haematobium* identification training-transfer program

1. Superintend the *S. haematobium* identification training-transfer program
2. Discuss details and directions of *S. haematobium* identification training-transfer program with Mrs. Sindisiwe Dlamini and Mrs. Gugu Maphalala
3. Negotiate the details of workshop and onsite training with Senior Medical Officers (SMOs) of RFM, HKGH, LGH and PPGH.
4. Teaching lectures and laboratory courses of *S. haematobium* identification training-transfer program
5. Report writing

Associate Prof. Po-Ching Cheng, collaborator of *S. haematobium* identification training-transfer program

1. Discuss details and directions of *S. haematobium* identification training-transfer program with Mrs. Sindisiwe Dlamini and Mrs. Gugu Maphalala
2. Negotiate the details of workshop and onsite training with Senior Medical Officers (SMOs) of RFM, HKGH, LGH and PPGH.
3. Teaching lectures and laboratory courses of *S. haematobium* identification training-transfer program
4. Report writing

Chia-Mei Chou, assistant of *S. haematobium* identification training-transfer program

1. Teaching laboratory courses of *S. haematobium* identification training-transfer program
2. Recording and analyzing urine and stool samples
3. Report writing

Ⅲ. Schedule of *S. haematobium* identification training-transfer program

The duration is 31 days, form Jun. 30, 2018 to Jul. 31, 2018.

Ⅳ. Results of *S. haematobium* identification training-transfer program

A. Results of laboratory technicians training in hospitals

There were 51 laboratory technicians attending the "*S. haematobium* identification training-transfer program" this year; including 19 technicians in national workshop at Mbabane Government Hospital (MGH) on Jul. 4th and 5th, 9 technicians in onsite training held at MGH on Jul. 6th, 4 technicians at Piggs Peak Government Hospital (PPGH) on Jul. 10th and 11th, 12 technicians at Raleigh Fitkin Memorial Hospital (RFM) on Jul. 16th and 17th, 3 technicians at Lubombo Government Hospital (LGH) on Jul. 18th and 19th, 4 technicians at Hlatikulu Government Hospital (HGH) on Jul. 24th and 25th. Attending laboratory technicians in each hospital are listed in the table below (Table 2). After the training, they are all received the training certificate to prove the completed workshop (Figure 7). All of the attendants were accepted pre-test before the lectures and had post-test after practical courses to evaluate the status of capacity improvement. The overall average of pre-test was 61.4 and the average of post-test was 68.0. In the case of training sessions in respective hospitals, the training of technicians in non-capital areas have been greater progressed. For the MGH national workshop, the pre-test scores were 62.8 points, and the post-test scores were 68.0 points; in MGH onsite training was 78.5 points to 74.5 points, and for the hospitals of other provinces, for PPGH increased from 57.0 points to 71.1 points; RFM rose from 50.8 points to 60.8 points; LGH rose from 56.0 points to 64.0 points, and HGH rose from 58.7 points to 80.0 points. Totally, the ability of attendants to identify *schistosoma* and other worm eggs after the training course showed good progress (Figure 3). The results also showed that the annual training course for

parasite eggs identification re-education is indeed improving the capacity of clinical diagnosis and identification of Swazi laboratory technicians. The pre-test scores of Swazi laboratory technicians, especially in the Capital Hospital have risen significantly than that of last year.

In addition, a questionnaire for the satisfaction of the participants in the training program course was conducted to understand and evaluate the acceptance and suggestions for the training-transfer program. The survey results after statistical analysis are shown in Figure 4. The participated laboratory technicians gave a high evaluation of the overall training-transfer course, with an average of 95 points or more (total 100%). Most of the participants were satisfied with the course content arrangement, analysis of the discriminative ability and the poster design of the parasite map (Excellent up to 50%); and they also satisfied on the lectures performance of the teachers, the education training manual and the experimental training course (Excellent up to 70%). Meanwhile, the participants were familiarize themselves with the "CTMS" and MIF diagnostic methods through this training-transfer program and considered is helpful in future clinical diagnosis and research work. They are also agreed that laboratory and medical units should introduce these two new diagnostic techniques. The results of this training-transfer program will contribute to the promotion of new diagnostic methods in the future.

B. Results of urine and stool samples analysis

In the results of clinical urine and stool samples examine by using CTMS and MIF method, a total of 264 urine samples and 258 stool samples were collected from primary school children belonging to six different regions. The average age of the students was 9.0 years old, of which Mkhuzweni Elementary School of RFM Hospital was the youngest at 7.0 years old, and Manyeveni Elementary School of LGH Hospital was 12.3 years old; the ratio of male to female was 179:85 for urine samples and 181:77 for stool samples. Figure 5 showed the results of the *Schistosoma* test. The *Schistosoma* infection of the primary school children in Swaziland was still as high as 11.4% (30/264), and the positive rate of the age-group at 5-12 was 12.3% (27/219), which was higher than 6.7% (3/45) of the age-group above 13. The Mkhuzweni Elementary School of RFM Hospital and Mlumati Elementary School of PPGH Hospital had the highest infection rates at 17.8% (21/118) and 17.2% (5/29),

respectively. Secondly, the Nhletjeni Elementary School of HGH Hospital was 12.5% (2/16) and the Cinisweni Elementary School of MGH Hospital was 5.4% (2/37). In the remaining primary schools, no eggs were found in the urine samples of school children. In terms of stool samples, a total of 258 specimens were examined. The results showed that there were no cases of *Schistosoma mansoni* in the stools of the six primary schools in the districts, regardless of male or female or any age (Figure 6). On the other hand, MIF method was used for the fecal specimens to diagnose infections of intestinal parasites. Figure 7 showed that the intestinal parasite diagnosis found only parasitic protozoa whereas no helminthic eggs infection, and the overall infection rate was as high as 37.6% (97/258), of which the positive rate of up-13-years old group was 45.5% (20/ 44), greater than 36.0 % of 5-12 years-age group (77/214). In terms of the primary schools in each district, the Mkhuzweni Elementary school of PPGH Hospital and the Mlumati Elementary School of RFM Hospital had both high infection rate of 55.2% (11/29) and 40.0% (46/115), respectively; followed by the Cinisweni Elementary school of MGH Hospital is 35.7% (5/14) and Manyeveni Elementary School of Ligh Hospital is 33.3% (17/51). The last are 29.4% in Bhekephi Elementary School of MGH Hospital (10/34) and 20.0% Nhletjeni Elementary School of HGH Hospital (3 / 15), respectively. The infected protozoa species included *E. histolytica/dispar*, *E. coli, B. hominis, I. butschlii, G. lamblia* and *E. nana,* and of which the main species are infected with *B. hominis* (49 /97), followed by *E. coli* (32/97) and *G. lamblia* (25/97), then followed by *E. nana* (14/97), and finally are *E. histolytica/dispar* and *I. butschlii* (9/97 and 8/97), respectively. In terms of the different surveying districts, Mkhuzweni Elementary School of RFM Hospital, Mlumati Elementary School of PPGH Hospital and Manyeveni Elementary School of LGH Hospital had the most seriously infections. The proportion of multiple primary infection samples in the three schools was over 35%, and it was 39.9% (18/49), 37.5% (6/16) and 35.3% (6/17), respectively. This result showed that Swaziland people, especially in the rural areas, were still exposed to the high risk of infection of intestinal protozoa, and also showed that MIF staining can be used to screen intestinal protozoa infections from randomly sampled fecal specimens. The sensitivity of MIF is good and can also help improve the identified ability of the laboratory technicians for intestinal parasites.

Ⅴ. Comments and Suggestions

The "*Schistosomiasis haematobium* identification training-transfer program in the Kingdom of Eswatini" implemented in the Kingdom of Eswatini uses the "Chamber-Tube Microscopic Slide System" to detect actual *schistosoma* infection in the urine of Swazi school-age children, hereby providing the local schistosomiasis screening and training the identified ability of the laboratory technicians, and to establish baseline data for the schistosomiasis reference, further assisting the establishment of the “Diagnosis-Treatment-Tracking System for *Schistosoma* Infection among Schoolchildren”. Through effective prevention measures to avoid the harm of schistosomiasis to children is more important. The overall results showed that the relevant education program is accompanied by training-transfer new technology, which really assists the Swazi clinical and laboratory technicians to strengthen their independently ability of screening for schistosomiasis and intestinal parasitic infections. In the training course, the local clinical and laboratory technicians actually operated the CTMS and MIF diagnostic methods commonly used by the Taiwan CDC and hospitals, which can significantly improve the clinical diagnosis and disease control of schistosomiasis and other intestinal parasites in Swaziland.

The program is mainly executed by the teachers and staffs of the Tropical Medical Center, Taipei Medical University in Swaziland, and closely cooperates with the members of Swaziland Health Laboratory Services, Swaziland National Blood Transfusion Service and National Bilharzia Worm Control Program. In addition to establishing good relations with multi-agencies, we are also more familiar with the model of official cooperation with Swaziland. Taking the program of this year as an example, the urine and fecal samples of the schoolchildren were previously collected by the staffs of the National Bilharzia Worm Control Program, for the laboratory technicians to practice screening of schistosomiasis in on-site training; which greatly improved the efficiency of program executing, not only shortening the preparation time and simplifying the related administrative procedures, but also making the workshop training smoother. After the samples surveying, the results of the parasite infection obtained by each elementary school are immediately reported to the Swazi National Bilharzia Worm Control Program, so that their staffs can quickly implement subsequent clinical treatment and deworming work. The improvements are also attributed to the accumulated results of previous years' programs, which will be more

effectively to prepare the deworming plan for schistosomiasis and intestinal parasites in elementary schools nationwide in the future.

Since the executed time of this plan was the winter of Swaziland, although there are some cases of schistosomiasis been diagnosed in this season (June-August); due to the cold weather, the frequency of children and adults go into the water for the playfulness or the daily family life such as water intake or laundry will decrease, so the positive rate of the screening will be also low in this season. Additionally, this time screening was carried out after the previous deworming administration of the Swazi National Bilharzia Worm Control Program, so the actual prevalence rate of Swaziland may be higher than the results of this survey. However, in the course of the implementation of this training program and the actual experimental operation, it is obvious that the in-depth understanding and alertness of schistosomiasis from Swazi laboratory technicians and even the general public are few aware than the other infectious diseases, such as malaria and tuberculosis. Although most technicians know that hematuria is caused by *Schistosomiasis haematobium*, they are not clear that serious complications may occur after infection. The effective prevention measures and control methods are still not well understood by Swazi technicians, let alone the general public's negligence and misunderstanding of this parasitic disease. Prof. Fan previous study found that Swazi schistosomiasis prevention involves social and cultural factors. The study pointed out that primary schoolchildren are high-risk groups with schistosomiasis in Swaziland, and the knowledge, attitudes, and practices (KAP) for the schistosomiasis have obviously affected the prevalence of this parasite disease. Controlling schistosomiasis requires empowering knowledge for children to improve their understanding of schistosomiasis in an attempt to change their exposure to water and the ways to improve excreta disposal (Maseko et al., 2018). Another research of the malaria prevention and treatment in Swaziland also showed the same conclusion (Dlamini et al., 2017). Therefore, it is necessary to strengthen the correct understanding of schistosomiasis and the health education related to epidemic prevention to the community, especially the young children; and cooperating with effective quarantine measures to reduce the infection of the disease in the future.

Correct and rapid diagnosis is a key step to effectively control of schistosomiasis. The lack of reliable and reasonably priced diagnostic tools is one of the factors that make prevention and treatment difficult (Bergquist, 2002; Hamilton et al., 1998; Xiang et al.,

2003). Conventional methods traditionally used to diagnose schistosomiasis are likely time- and labor-consuming, and the sensitivity may be slightly less obvious in mild infections (de Vlas and Gryseels, 1992; Ross et al., 2001; Wu, 2002). The method of the *schistosoma* egg detection in urine samples used by the Swazi National Bilharzia Worm Control Program is still the syringe-membrane filtration method that currently recommended by WHO. However, the steps of the syringe membrane filtration method are cumbersome and also susceptible to the interference of impurities in the urine; meanwhile, the cost required for the consumables is not cheap. In contrast, the CTMS systems used in urinary sediment testing of major hospitals in Taiwan are cheaper and more efficient, will reduce the economic burden of performing large-scale screenings in Africa. In the program, we used CTMS and syringe membrane filtration diagnostic methods to detect Swazi schistosomiasis and found that the difference of sensitivity and specificity between the two methods is small; but the CTMS operation avoided the filtering step in each sample and shortened the operating time by laboratory technicians. Secondly, in the step of membrane filtration, many urine samples contained a large amount of impurities such as urine sediment or crystals, which may cause the filter membrane to be completely covered and cannot be observed with a microscope. Moreover, the CTMS method can handle 10 specimens on a single slide at the time of screening, which is faster and more efficient than the syringe membrane filtration method. The screening results detected that up to 11.4% of the infection rate of *Schistosoma haematobium* among the Swazi primary school children, especially in the lower age group; and many severely infected urine samples were in the non-capital areas, the Mkhuzweni Elementary School of RFM hospital and the Mlumati Elementary School of PPGH Hospital. We even found dozens of *schistosoma* eggs in a urine sample of a schoolchild and that clearly revealed the *schistosoma* infection remains a very serious problem among primary school children in the Kingdom of Eswatini. It is consistent with the previous study by the principal investigator that the Swazi primary school children are the high-risk group with schistosomiasis (Maseko et al., 2018). In addition, we found that there were no *Schistosoma mansoni* eggs in the fecal samples of primary school children in all regions. Whether it is related to the ecological distribution of the local intermediate hosts and may be needed to further evaluate the environmental water source in the infected area for explain.

In September 2015, the United Nations mentioned in the Sustainable Development Goals (SDGs) to end the epidemic of AIDS, tuberculosis, malaria and neglected tropical diseases by 2030, and fight against hepatitis and waterborne diseases and other infectious diseases, and emphasizes "mobilizing and sharing knowledge, professionalism, technology and financial support through multilateral cooperation to enhance global cooperation in sustainable development to assist all countries in achieving sustainable development goals, especially the developing countries". This project is the actual result of reflecting the two development goals. The "*Schistosomiasis haematobium* identification training-transfer program in the Kingdom of Eswatini" hopes to further promote Taiwan's techniques and experiences in screening and controlling parasites to the Kingdom of Eswatini, hereby to enhance the international status and importance of Taiwan in Africa or even the world. Through the TMU parasite research team and the Swaziland Health Laboratory Services, Swaziland National Blood Transfusion Service and National Bilharzia Worm Control Program working together, we help to solve the actual problems in the prevention of tropical diseases, to pragmatically highlight the contribution of TMU and Taiwan in the health care system of the world. It is very important in the diplomatic dilemma faced by Taiwan, or even in the future, whether we can be smoothly integrated into the field of international health such as WHO.

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Ministry of Health in the Kingdom of Eswatini

Tomorrow Medical Foundation

Mrs. Sindisiwe Dlamini, Director of Swaziland Health Laboratory Services

Mrs. Gugu Maphalala, Technical Director of Swaziland National Blood Transfusion Service

Mrs. Precious Dlamini, Director of National Bilharzia (Schistosomiasis) Worm Control Program

Mrs. Fortunate Lushaba, Technician of Swaziland Health Laboratory Services

Mbabane Government Hospital, Hhohho, Kingdom of Eswatini

Raleigh Fitkin Memorial Hospital, Manzini, Kingdom of Eswatini

Hlatikhulu Government Hospital, Shiselweni, Kingdom of Eswatini

Lubombo Government Hospital, Lubombo, Kingdom of Eswatini

Piggs Peak Government Hospital, Hhohho, Kingdom of Eswatini

Attachments

1. The Swaziland Health Laboratory Services issued a notice of training-transfer program to the clinical labs of different hospitals.

MINUTE

Training is Approved
Ag. DHS
11/06/18

DIRECTOR OF HEALTH SERVICES
MINISTRY OF HEALTH
4 JUN 2018
P.O. BOX 5, MBABANE
SWAZILAND

To: Deputy Director of Health Services
Ministry of Health

Re: **Training – transfer program for rapid schistosomiasis diagnosis by Chamber-Tube Microscopic Slide System (CTMS) and Merthiolate-Iodine-Formaldehyde (MIF) methods in the kingdom of Swaziland**

The Taiwan Medical Mission in the kingdom of Swaziland in collaboration with the Swaziland Health Laboratory operating under the Swaziland Government Ministry of Health is conducting the above mentioned training for Laboratory personnel from the 04th – 25th July 2018.

The main objectives of the training are:

1. The training-transfer program in 2018 will focus on the new and powerful diagnostic technique assessed by CTMS and MIF methods, to investigate the prevalence of the S. haematobium and S. mansoni infection in the primary schoolchildren and/or outpatients by on-site trainings in Swaziland.
2. To compare respective efficiency, sensitivity and specificity among syringe-membrane filtration method recommended by WHO, simple sedimentation concentration used recently in Swaziland laboratory and the CTMS for urinary bilharzia diagnosis
3. To promote the diagnostic abilities of schistosomiasis among clinical lab technicians in governmental and private hospitals.

The training will be in different health facilities to enable all technologists to learn the skill:

- Mbabane Government Hospital - 04th – 06th July 2018
- Piggs peak Government Hospital - 10th – 11th July 2018
- RFM Hospital - 16th – 17th July 2018
- Lubombo Refferral Hospital - 18th – 19th July 2018
- Hlathikulu Government Hospital - 24th – 25th July 2018

We kindly request for your approval in this training. Please find attached the schedule, and agenda for the training.

Sincerely

HEALTH LABORATORY SERVICES
P.O. BOX 6849
MBABANE H100
07 JUN 2018
CHIEF MEDICAL LABORATORY TECHNOLOGIST
MOH

Ms Sindisiwe Dlamini
Chief Medical Laboratory Technologist
(Swaziland Health Laboratory Service)

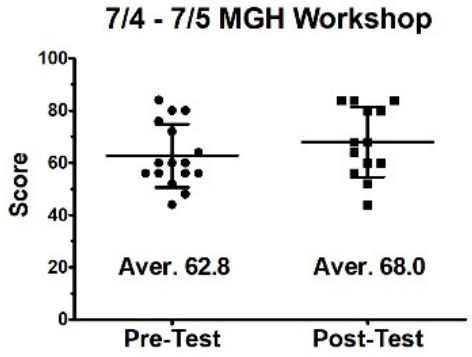
07.06.2018

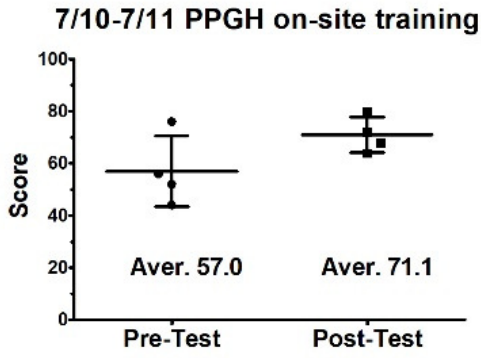
2. Name list of medical technicians from all hospitals who participated in *Schistosomiasis haematobium* identification training-transfer program in the Kingdom of Eswatini, 2018:

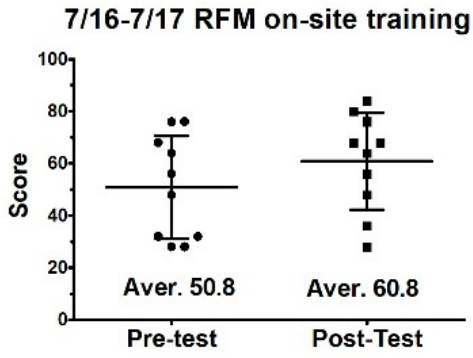
Course content	Date and hospital	Name of trainee	Affiliation of trainee
Workshop	**Mbabane Government Hospital (7/4-7/5)**	1. Philton Ndzinisa	SHLS
		2. Derrick Khumalo	SHLS
		3. Nomcebo Phungwayo	MGH
		4. Phumelele Manana	MGH
		5. Sabelo Dlamini	NBTS
		6. Nomvuyo Mabuza	MGH
		7. Andiswq Dlamini	MGH
		8. Khanyisile Simelane	MGH
		9. Nondumiso Nhlengethwa	MGH
		10. Eric Ekute	MGH
		11. Godfrey Vaiya	MGH
		12. Sindisiwe Dlamini	MGH
		13. Fortunate Lushaba	MGH
		14. Gilbert Masona	RFM
		15. Patricia Lungu	Hlatikulu
		16. Ntombizile Dlamini	TB Hospital
		17. Musawenkhosi Mtuli	Mankayane
		18. Smangele Msibi	GSH
		19. Philile Thwala	Lubombo
On-site training	**Mbabane Government Hospital (7/6)**	1. Gugu Tsabedze	MGH
		2. Mathabiso Shabangu	MGH
		3. Phetsile Dlamini	NBTS
		4. Samkelisiwe SHongwe	MGH
		5. Dumile Sibandze	MGH
		6. Ayanda Ngwenya	MGH
		7. Patrick Muyaya	Baylor Lab
		8. Farai Hweju	MGH
		9. Muambi Muyaya	Baylor Lab
On-site training	**Piggs Peak Government Hospital (7/10-7/11)**	1. Victoria Katungu	Piggs Peak
		2. Wilson Mukotsanjera	Emkhuzweni
		3. Benson Shimbria	Dvokolwako
		4. Nobuhle Tumeletsi	PPK
On-site training	**Raleigh Fitkin Memorial Hospital (RFM) Hospital (7/16-7/17)**	1. Johannes Majada	RFM
		2. Brains Msbi	RFM
		3. Oupa Dlamini	TB Hospital
		4. Thulani Kunene	TB Hospital

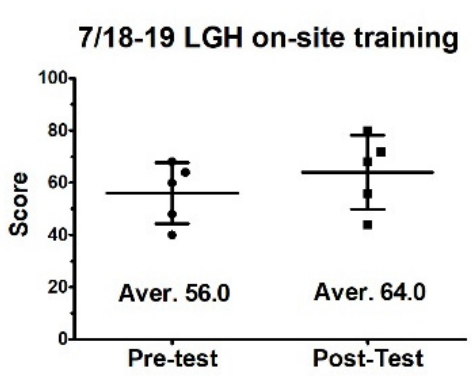
		5. Rumbidzai Dodzo	Mankayane
		6. Rhumlani Motsa	Bilhazia Unit
		7. Susan Mkhonta	Bilhazia Unit
		8. Chazile Mtshali	Bilhazia Unit
		9. Khanyisile Nhlabatsi	Bilhazia Unit
		10. Lompulazi Lessiah Dlamini	Bilhazia Unit
		11. Sanele Dlamini	Bilhazia Unit
		12. Qiniso Dlamini	Bilhazia Unit
On-site training	**Lubombo Government Hospital (7/18-7/19)**	1. Kenny Simfukwe	GSH
		2. Tony Adjuk	GSH
		3. Josephine Jonato	Lubombo
On-site training	**Hlatikulu Government Hospital (7/24-7/25)**	1. Nester Dlamini	Hlatikulu
		2. Wistone Dlamini	Nhlangano
		3. Nomcebo Zondo	Matsanjeni
		4. Precious Dlamini	Bilhazia Unit

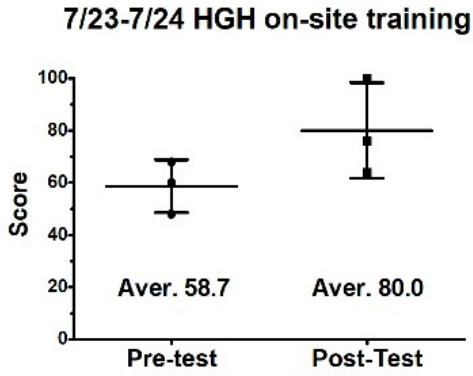
3. Pre-test and post-test scores of trainees in various hospitals:

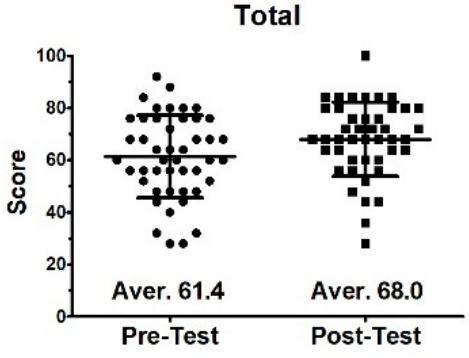






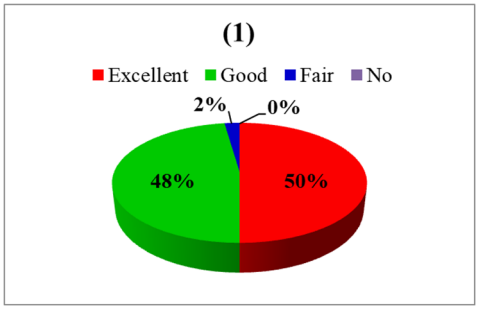




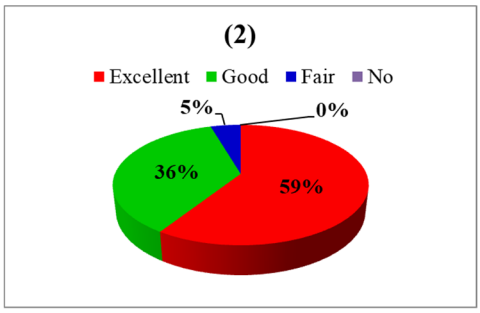


4. The satisfaction Investigation of participated trainees for the schistosomiasis training-transfer program

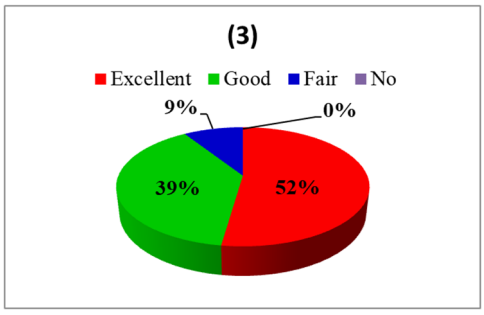
(1). Do you think this CTMS and MIF Methods training-transfer program is useful to your future lab work?



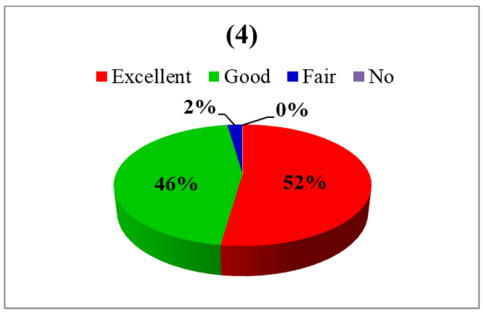
(2). The pre-test is to know your capability in the identification of the intestinal parasites & Bilharzia, do you think it useful to help you understand your ability in the identification of these parasites?



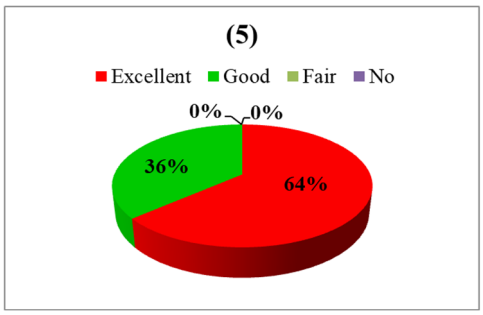
(3). Do you think the Keynote address: Introduction of Schistosomiasis along with the clinical complications?



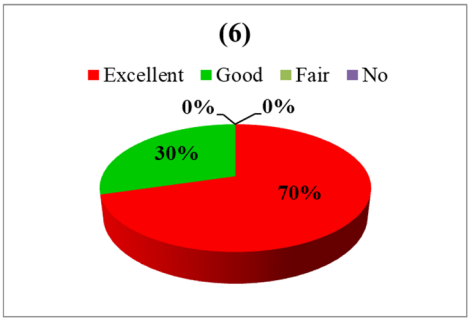
(4). Do you think the CTMS/MIF methods introduction (last two pages in the booklet) is useful to make you be familiar with these new diagnostic systems?



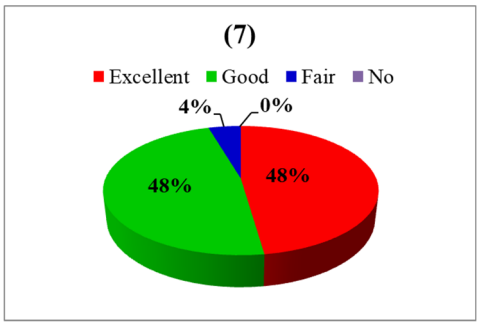
(5). Do you think the IP/ Bilharzia Identification skill (training course) is useful to make you be familiar with the identification skills on intestinal parasites & Bilharzia?



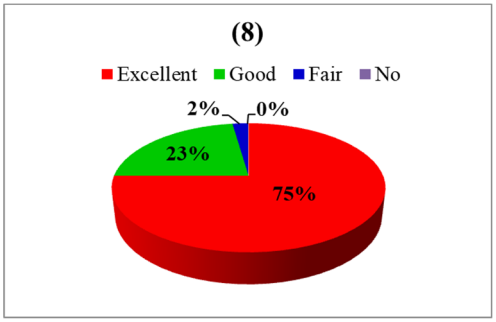
(6). Do you think the lab practice is useful to make you more familiar with the performing procedure and identification skills on intestinal parasites & Bilharzia?



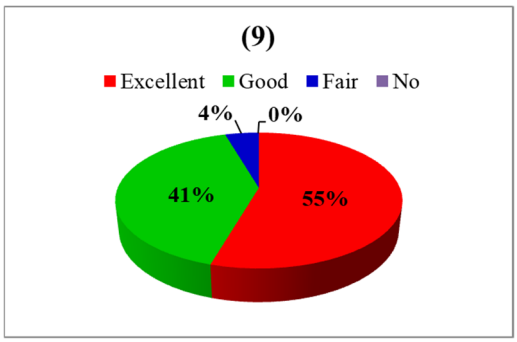
(7). The post-test is to know the learning outcome in the identification of the intestinal parasites & Bilharzia, do you think it useful to make you understand more about your ability in identification skills?



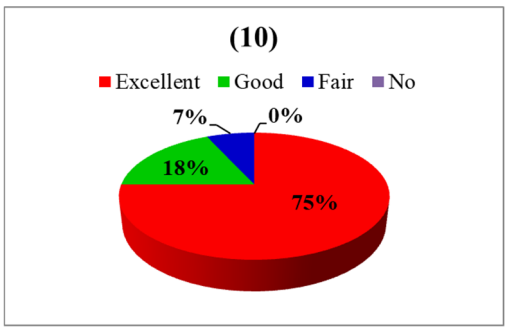
(8). Do you think the booklet for this workshop is very nice to be understandable and readable?



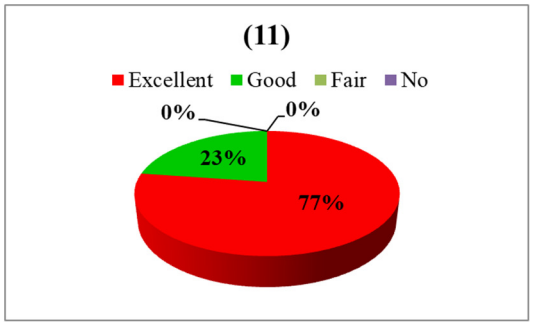
(9). What is your evaluation about Color Atlas of intestinal parasites & Bilharzia in Swaziland in the booklet?



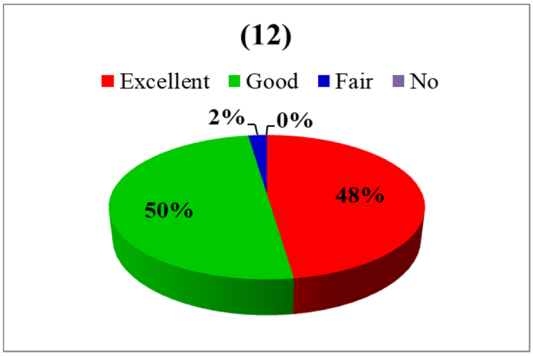
(10). Will you consider inviting Prof. Fan & Cheng with his team to continue providing the CTMS/MIF training-transfer workshop in next year?



(11). Do you think Lab Medicine Department should be equipped with these two new diagnostic systems?



(12). Overall, what's your evaluation of this 2-days workshop?


(12)
Excellent
Good
Fair
No
2%
0%
48%
50%

5. The infection rate of *S. haematobium* in primary school children from different hospitals

A

School Name	No.	Aver. Age	*S. haematobium* infection No. (%)
Bhekephi	37	8.2	2 (5.4%)
Male	27	8.7	2 (7.4%)
Female	10	6.9	0 (0%)
Cinisweni	13	9.5	0 (0%)
Male	7	11.4	0 (0%)
Female	6	7.3	0 (0%)
Mlumati	29	11.0	5 (17.2%)
Male	19	10.8	2 (10.5%)
Female	10	11.5	3 (30%)
Mkhuzweni	118	7.0	21 (17.8%)
Male	84	7.0	16 (19.0%)
Female	34	8.9	5 (14.7%)
Manyeveni	51	12.3	0 (0%)
Male	38	12.1	0 (0%)
Female	13	12.6	0 (0%)
Nhletjeni	16	10.6	2 (12.5%)
Male	4	11.5	1 (25.0%)
Female	12	10.3	1 (8.3%)
Total	264	9.0	30 (11.4%)
Male	179	9.0	21 (11.7%)
Female	85	8.8	9 (10.6%)

B

School Name	No.	*S. haematobium* infection No. (%)
Bhekephi	37	2 (5.4%)
5-12 years old	35	2 (5.7%)
≧13 years old	2	0 (0.0%)
Cinisweni	13	0 (0%)
5-12 years old	9	0 (0%)
≧13 years old	4	0 (0%)
Mlumati	29	5 (17.2%)
5-12 years old	21	3 (14.3%)
≧13 years old	8	2 (25.0%)
Mkhuzweni	118	21 (17.8%)
5-12 years old	118	21 (17.8%)
≧13 years old	0	0 (0%)
Manyeveni	51	0 (0%)
5-12 years old	22	0 (0%)
≧13 years old	29	0 (0%)
Nhletjeni	16	2 (12.5%)
5-12 years old	14	1 (7.1%)
≧13 years old	2	1 (50.0%)
Total	264	30 (11.4%)
5-12 years old	219	27 (12.3%)
≧13 years old	45	3 (6.7)

6. The infection rate of *S. mansoni* in primary school children from different hospitals

A

School Name	No.	Aver. Age	*S. mansoni* infection No. (%)
Bhekephi	34	8.4	0 (0%)
Male	28	8.7	0 (0%)
Female	6	7.2	0 (0%)
Cinisweni	14	9.9	0 (0%)
Male	7	12.0	0 (0%)
Female	7	7.7	0 (0%)
Mlumati	29	11.0	0 (0%)
Male	19	10.8	0 (0%)
Female	10	11.5	0 (0%)
Mkhuzweni	115	7.0	0 (0%)
Male	85	7.0	0 (0%)
Female	30	6.9	0 (0%)
Manyeveni	51	12.2	0 (0%)
Male	38	12.0	0 (0%)
Female	13	12.6	0 (0%)
Nhletjeni	15	10.6	0 (0%)
Male	4	11.5	0 (0%)
Female	11	10.3	0 (0%)
Total	258	9.0	0 (0%)
Male	181	9.0	0 (0%)
Female	77	9.1	0 (0%)

B

School Name	No.	*S. mansoni* infection No. (%)
Bhekephi	34	0 (0%)
5-12 years old	32	0 (0%)
≧13 years old	2	0 (0%)
Cinisweni	14	0 (0%)
5-12 years old	10	0 (0%)
≧13 years old	4	0 (0%)
Mlumati	29	0 (0%)
5-12 years old	8	0 (0%)
≧13 years old	21	0 (0%)
Mkhuzweni	115	0 (0%)
5-12 years old	115	0 (0%)
≧13 years old	0	0 (0%)
Manyeveni	51	0 (0%)
5-12 years old	23	0 (0%)
≧13 years old	28	0 (0%)
Nhletjeni	15	0 (0%)
5-12 years old	13	0 (0%)
≧13 years old	2	0 (0%)
Total	258	0 (0%)
5-12 years old	214	0 (0%)
≧13 years old	44	0 (0%)

7. The infection rate of intestinal parasites in primary school children from different hospitals

A

School Name	No.	Aver. Age	Intestinal parasites infection No. (%)
Bhekephi	34	8.4	10 (29.4%)
Male	28	8.7	7 (25.0%)
Female	6	7.2	3 (50.0%)
Cinisweni	14	9.9	5 (35.7%)
Male	7	12.0	3 (42.9%)
Female	7	7.7	2 (28.6%)
Mlumati	29	11.0	16 (55.2%)
Male	19	10.8	11 (57.9%)
Female	10	11.5	5 (50.0%)
Mkhuzweni	115	7.0	46 (40.0%)
Male	85	7.0	33 (38.8%)
Female	30	6.9	13 (43.3%)
Manyeveni	51	12.2	17 (33.3%)
Male	38	12.0	13 (34.2%)
Female	13	12.6	4 (30.8%)
Nhletjeni	15	10.6	3 (20%)
Male	4	11.5	0
Female	11	10.3	3 (27.3%)
Total	258	9.0	97 (37.6%)
Male	181	9.0	67 (37.0%)
Female	77	9.1	30 (39.0%)

B

School Name	No.	Intestinal parasite sinfection No. (%)
Bhekephi	34	10 (29.4%)
5-12 years old	32	10 (31.3%)
≧13 years old	2	0 (0.0%)
Cinisweni	14	5 (35.7%)
5-12 years old	10	4 (40.0%)
≧13 years old	4	1 (25.0%)
Mlumati	29	16 (55.2%)
5-12 years old	8	5 (62.5%)
≧13 years old	21	11 (52.4%)
Mkhuzweni	115	46 (40.0%)
5-12 years old	115	46 (40.0%)
≧13 years old	0	0 (0%)
Manyeveni	51	17 (33.3%)
5-12 years old	23	3 (13.0%)
≧13 years old	28	14 (50%)
Nhletjeni	15	3 (20%)
5-12 years old	13	3 (23.1%)
≧13 years old	2	0
Total	258	97 (37.6%)
5-12 years old	214	77 (36.0%)
≧13 years old	44	20 (45.5%)

8. The infection status of intestinal parasites among 6 primary schools.

School Name	No.	Helminths No. (%)	Protozoa No. (%)	Single infection No. (%)	Multiple infection No. (%)	*E. histolytica/disapr* infection No. (%)	*G. lamblia* infection No. (%)	*E. coli* infection No. (%)	*I. buetschii* infection No. (%)	*B. hominis* infection No. (%)	*E. nana* infection No. (%)
Bhekephi	34	0 (0.0%)	10 (29.4%)	9 (90.0%)	1 (10.0%)	1 (10.0%)	0 (0.0%)	2 (20.0%)	0 (0.0%)	7 (70.0%)	1 (10.0%)
Cinisweni	14	0 (0.0%)	5 (35.7%)	4 (80.0%)	1 (20.0%)	0 (0.0%)	1 (20.0%)	0 (0.0%)	0 (0.0%)	4 (80.0%)	1 (20.0%)
Mlumati	29	0 (0.0%)	16 (55.2%)	10 (62.5%)	6 (37.5%)	4 (25.0%)	3 (18.8%)	3 (18.8%)	2 (12.5%)	7 (43.8%)	6 (37.5%)
Mkhuzweni	115	0 (0.0%)	46 (40.0%)	28 (60.9%)	18 (39.9%)	3 (6.5%)	16 (34.8%)	18 (39.1%)	5 (10.9%)	22 (47.8%)	4 (8.7%)
Manyeveni	51	0 (0.0%)	17 (33.3%)	11 (64.7%)	6 (35.3%)	1 (5.9%)	3 (17.6%)	9 (52.9%)	1 (5.9%)	8 (47.1%))	2 (11.8%)
Nhletjeni	15	0 (0.0%)	3 (20%)	3 (100%)	0 (0.0%)	0 (0.0%)	2 (66.7%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	0 (0.0%)
Total	258	0 (0.0%)	97 (37.6%)	65	32	9	25	32	8	49	14

9. Photos of course activities in the workshop and on-site trainings

(1). Photos of each participant in workshop and on-site trainings

A. Participated Trainee chartered photo in MGH (Workshop)


B. Participated Trainee chartered photo in MGH (on-site training)









C. Participated Trainee chartered photo in PPGH




D. Participated Trainee chartered photo in LGH





E. Participated Trainee chartered photo in RFM







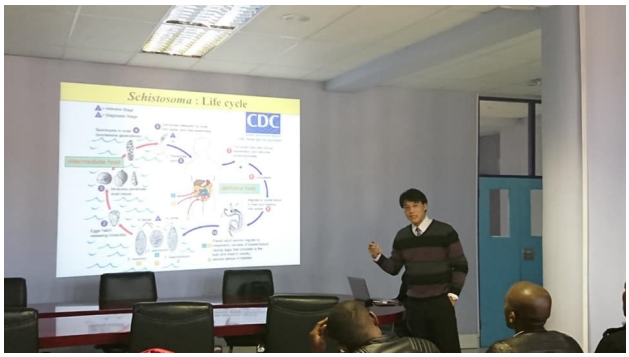


F. Participated Trainee chartered photo in HGH

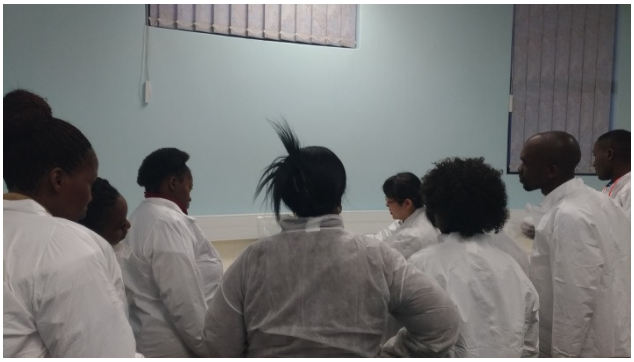
(2). Activity photos of workshop and on-site trainings

A. Group photograph of the screening and identification teaching workshop for schistosomiasis on Jul. 4th and 5th.

All participating teacher and staff and workshop trainees



Teaching lecture for schistosomiasis



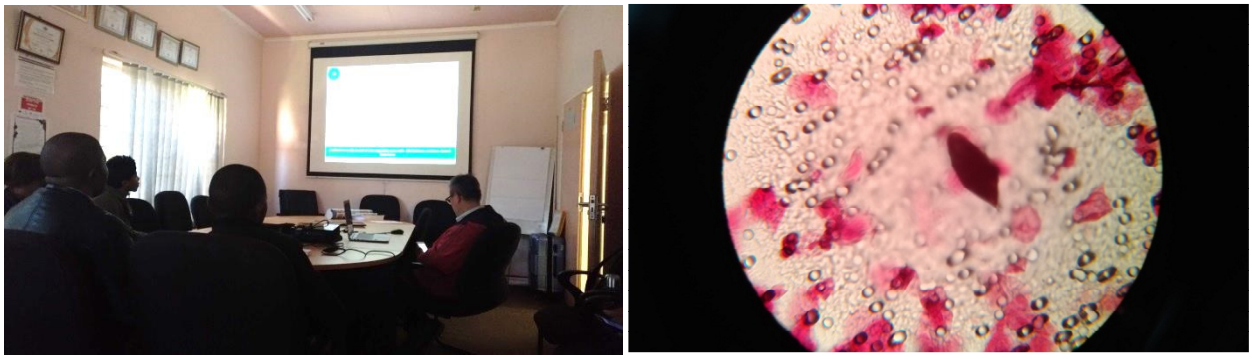
Explanation and guidance for experimental operation in workshop

B. Photograph of the on-site training for schistosomiasis at MGH on Jul. 6th

Photos of participated trainees and experimental operations

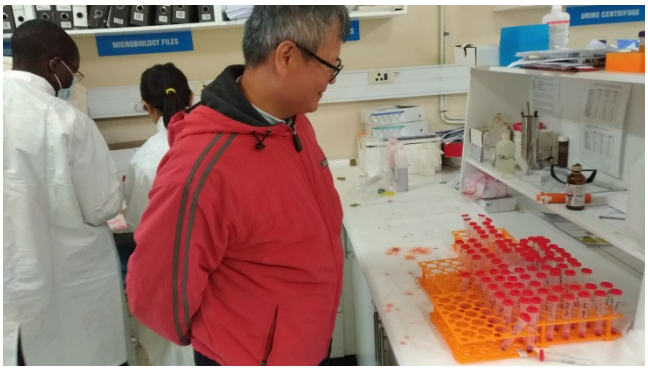
C. Photograph of the on-site training for schistosomiasis at PPGH on Jul. 10th and 11th

Trainees actually participated in the experimental operation for parasite screening of the local school children

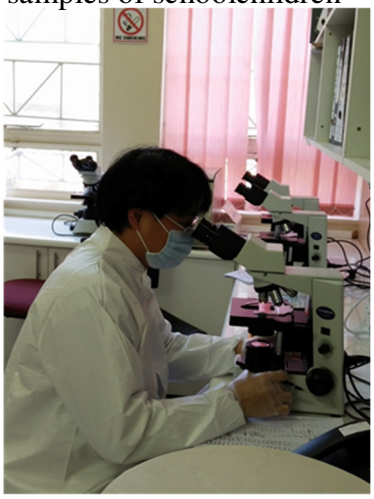
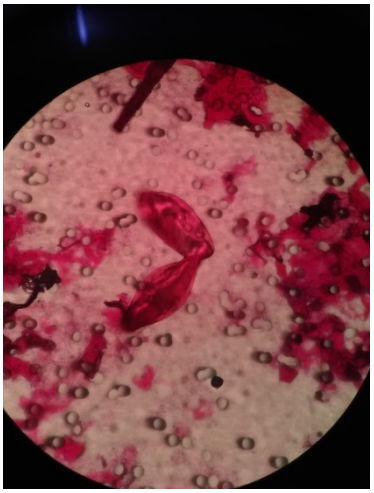


The post-test of parasite egg identification after the course end and found the egg of *Schistosoma haematobium* in the urine samples of school children

D. Photograph of the on-site training for schistosomiasis at RFM on Jul. 16th and 17th

Trainees participate in the registration and grouping the collected urine and stool samples of schoolchildren

The actual detection found there were a large number of infected *Schistosoma haematobium* eggs in the urine of the school children in the area.

E. Photograph of the on-site training for schistosomiasis at LGH on Jul. 18th and 19th

Teaching lecture for schistosomiasis and guidance for experimental operation

F. Photograph of the on-site training for schistosomiasis at LGH on Jul. 24th and 25th


Instructions for the hospital's SMO before on-site training and teaching lecture for schistosomiasis

G. Photograph of visiting the Swazi Malaria Control Center on Jul. 26th

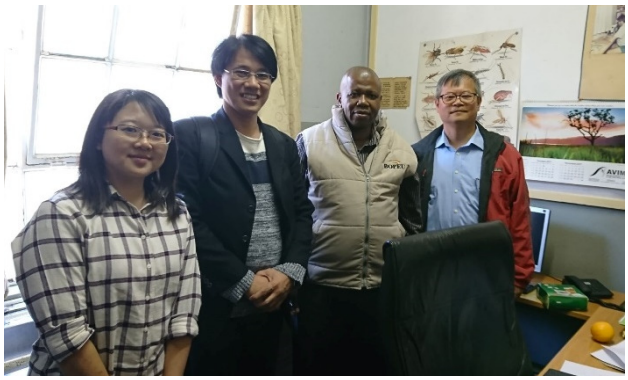



Photo with the director and staffs of the center


Briefing instructions for the business of malaria control center and Swazi infection status and discuss cooperation issues in future